VOL. 74, NO. 2 FEBRUARY, 1941

THE PHILIPPINE JOURNAL OF SCIENCE

BUREAU OF SCIENCE
MANILA

MANILA
BUREAU OF PRINTING
1941

43818

THE PHILIPPINE JOURNAL OF SCIENCE

Published by the Bureau of Science, Department of Agriculture and Commerce

[Entered at the Post Office at Manila, Philippines, as second-class matter.]

THE PHILIPPINE JOURNAL OF SCIENCE

VOL. 74 FEBRUARY, 1941 No. 2

ON TWO NEW SPECIES OF THE FAMILY HYMENOLEPIDIDÆ FUHRMANN 1907 (CESTODA) FROM A BURMESE CORMORANT, PHALACROCORAX JAVANICUS (HORSFIELD, 1821).

By L. N. JOHRI

Of University College, Rangoon, Burma

FIVE TEXT FIGURES

The material described in this paper was collected from a Burmese cormorant, *Phalacrocorax javanicus* (Horsf. 1821), from the Rubber Plantations Gyogon, Insein District. On dissection 22 cestodes were found: 5 in the stomach, 5 in the duodenum, and 12 in the intestine. Of these, 5 were *Hymenolepis gyogonka* sp. nov., and the rest *Oligorchis burmanensis* sp. nov. Forty-eight nematodes and 1 trematode were also collected from the stomach and duodenum, respectively. In the following descriptions all measurements, unless otherwise stated, are given in millimeters.

Family HYMENOLEPIDIDÆ Fuhrmann, 1907

Subfamily HYMENOLEPIDINÆ Perrier, 1891

Genus OLIGORCHIS Fuhrmann, 1906

OLIGORCHIS BURMANENSIS sp. nov. Text figs. 1, 2, and 3.

Length 32 to 46. Maximum breadth 0.89. Scolex 0.375 to 0.4 in diameter. Rostellum 0.106 to 0.12 in diameter; rostellar hooks 22, 0.109 to 0.133 and 0.163 to 0.188 long, arranged in two alternating rows. Suckers spherical, 0.165 to 0.188 in diameter, unarmed. Genital pore unilateral in anterior half of proglottis margin; genital ducts passing dorsally to longitudinal excretory

vessels. Musculature with two layers of longitudinal muscles, bundles in inner layer very well developed and lined internally by feebly developed transverse muscles. Genital cloaca present. Cirrus sac 0.24 to 0.317 in maximum length in mature segments, in gravid segments up to 0.41; often with a well-marked twist and distal portion greatly curved; well past ventral longitudinal excretory vessel and extending a little over half the breadth of the proglottis. Cirrus spiny. Internal vesicula seminalis small, external vesicula seminalis not seen. Vas deferens with a few coils. Testes 0.048 to 0.083 in diameter, three of them usually in a transverse row nearly touching the posterior border of the proglottis, fourth anterior to aporal testis; poral and aporal testes partly overlapping ventral longitudinal excretory vessels. Ovary with small lobes laterally and posteriorly. Vaginal opening in genital cloaca ventral to cirrus sac (very well seen in transverse sections). Receptaculum seminis present. Uterus in early stage an irregular, branched sac, but at a later stage of development branching becoming more inconspicuous by anastomosis, extending laterally to ventral longitudinal excretory vessels. Eggs not fully developed, 0.02 by 0.026 to 0.023 by 0.034.

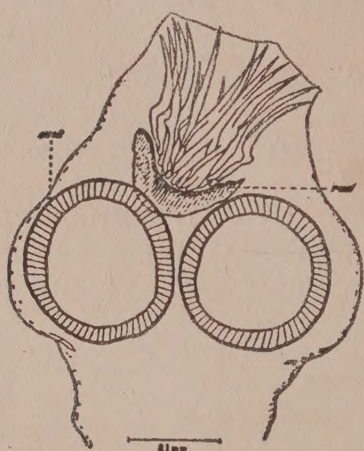


FIG. 1. *Oligorchis burmanensis* sp. nov.; scolex.

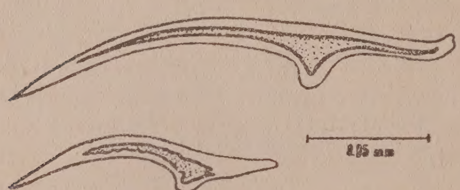


FIG. 2. *Oligorchis burmanensis* sp. nov.; rostellar hooks.

The genus *Oligorchis* Fuhrmann 1906 is stated by Baer (10, p. 76) Fuhrmann, (6, p. 158) Lühe, (12, p. 54) and Mayhew (13, p. 33) to be characterized by the possession of a single crown of the rostellar hooks. This character may be altered to admit the present form to avoid the confusion of shifting such forms to *Dilepis* Weinland 1834, which belongs to a different family. The author is of the opinion already suggested by Mayhew: (13, p.34)

The double crown of the hooks is not believed to be a character of sufficient importance to exclude it from the family Hymenolepididae. The constancy of the number of the testes in the numerous species of the several genera of the family is such an outstanding characteristic that it serves to separate this group of genera from other genera in a distinct and peculiar manner.

From the present species *O. yorkei* (Kotlan 1923) may be distinguished by difference in number and shape of the rostellar hooks; from *O. duboisi* (Hsü, 1935) and *O. heirticos* Johri, 1934, by the smaller size of the cirrus sac; while *O. toxometra* Joyeux and Baer, 1928, and *O. strangulatus* Fuhrmann, 1906, are distinguished by the smaller size of the rostellar hooks and their different shapes. *O. longivaginosus* Mayhew, 1925, is distinguished by characteristic division of the ovary into 4 to 6 knoblike lobes, an specially long vagina, and by the arrangement of the rostellar hooks in a single row and their uniform size.

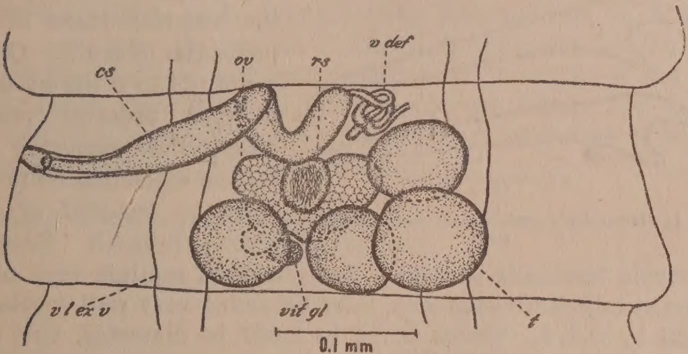


FIG. 3. *Oligorchis burmanensis* sp. nov.; mature proglottis.

O. delachauxi Fuhrmann, 1909 (which has been transferred by Joyeux and Baer to *Paradilepis macracantha*), has no scolex, but may be separated by the presence of female glands on the poral side of the segment. A new name, *Oligorchis burmanensis*, is, therefore, proposed for the present form.

In a recent paper Southwell and Lake(16) have added one more species, namely *Oligorchis kwangensis*, having 4 to 7 testes, and thus revived the discrepancy of the different genera of Hymenolepidinæ already cleared up by the writer (Report on a collection of cestodes from Lucknow (1934, p. 175) pointing out the constancy of the number of the testes. It is, therefore, fitting to transfer *O. kwangensis* to the genus *Pseudoligorchis* Johri, 1934. The point about the armed rostellum is not at all

disturbing, since there are many genera (*Hymenolepis* and *Tænia*, for example) under which both armed and unarmed rostellar forms are included in the constancy of the common characters. The author is in entire agreement with Meggitt (14) in considering the anatomy of the specimens as the sole basis for their identification, irrespective of the systematic position of the host.

Genus HYMENOLEPIS Weinland, 1858

HYMENOLEPIS GYOGONKA sp. nov. Text figs. 4 and 5.

Maximum length 63, greatest breadth 0.55. Scolex 0.114 to 0.128 in diameter. Rostellum 0.182 to 0.195 long, 0.053 to 0.66 in diameter. In the scoleces the rostellar hooks are always in the lower portion of the rostellum. Rostellar hooks 10, 0.018 to 0.026 long. Suckers spherical, 0.047 to 0.073 in diameter, without acetabular hooks. Segments much broader than long. Genital pores unilateral, in the anterior third of the proglottis margin. Cirrus sac 0.108 to 0.162 by 0.012 to 0.03, crossing ventral longitudinal excretory vessel and extending up to one-third to one-half of proglottis breadth. External vescicula seminalis present. Receptaculum seminis very insignificant in mature segments, later becoming very well developed, 0.128 by 0.074. Testes 0.048 to 0.067 in diameter, two in a posterior row, third exactly anterior to aporal testis, sometimes slightly between posterior testes. A portion of testes coming on ventral longitudinal excretory vessels. Uterus transversely

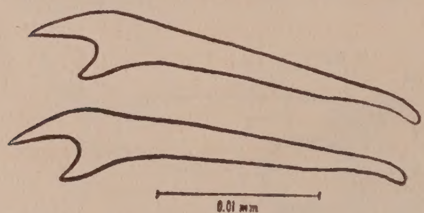


FIG. 4. *Hymenolepis gyogonka* sp. nov.; rostellar hooks.

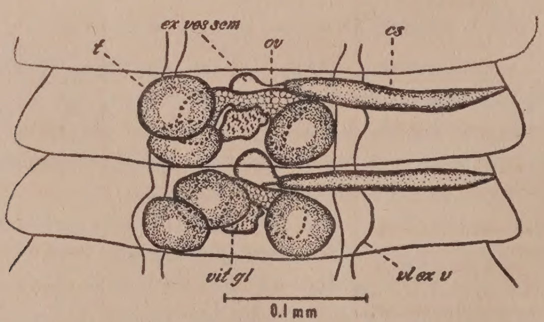


FIG. 5. *Hymenolepsis gyogonka* sp. nov.; mature proglottis.

elongated, irregular, sac-shaped, and extending laterally to longitudinal excretory vessels. Eggs not fully developed.

Of all the species of *Hymenolepis*, *H. æquabilis* (Rud., 1810), *H. amphitricha* Rud., 1819, *H. brasilense* (Fuhrmann, 1906), *H. capillaroides* Fuhrmann, 1906, *H. chionis* (Fuhrmann, 1921), *H. creplini* (Krabbe, 1869), *H. farciminosa* (Goeze, 1782), *H. filirostris* (Wed., 1855), *H. furcifera* (Krabbe, 1869), *H. hemignathi* (Shipley, 1898), *H. microscolecina* Fuhrmann, 1906, *H. multiglandularis* Baczynska, 1914, *H. podicepina* Linton, 1927, *H. victoriata* Inamdar, 1935, and *H. voluta* Linstow, 1904, have the same number of rostellar hooks (10) and the comparable size 0.018 to 0.038, but they are easily separated by the quite different shapes of their rostellar hooks. The remainder approach the number and size of rostellar hooks as shown in Table 1, in which the markedly different size of rostellar hooks differentiates groups A and B from the present form, except *H. intermedia* Clerc, 1906, which is easily distinguished by its very long cirrus sac. In groups C and D, 1/0.88 and 1/0.39, respectively, constitute sufficient difference in the shape of the rostellar hooks from group E; *H. fringillarum* (Rud., 1810), and *H. spinosa* Linstow 1906, are thus excluded, wherefore *Hymenolepis gyogonka* sp. nov. is established.

TABLE 1.—*Characters and measurements of species of Hymenolepis Weinland, 1858.*

Group.	Species.	Rostellar hooks.		Ratio of distance between point and guard of rostellar hook over total length of rostellar hook.	Cirrus sac.	
		Number.	Size.		Size.	Extent.
			mm.		*mm.*	
A	*H. ardæ* Linton, 1927	10	33	$\frac{1}{3}$:0.77–2:0.93	280	To venal excretory vessel.
	H. ambigua (Clerc, 1906)	10	30	$\frac{1}{3}$:0.58	180	
B	*H. intermedia* Clerc, 1906	10	22–25	$\frac{1}{4}$:0.61	360	Past long excretory vessel.
	H. magniovata Fuhrmann, 1918	10	30	$\frac{1}{3}$:0.9	100–120	Do.
C	*H. fringillarum* (Rud., 1810)	10	26–28	$\frac{1}{8}$:0.03	95–100	
D	*H. spinosa* Linstow, 1906	10	28	$\frac{1}{8}$:0.3	?	Past $\frac{1}{3}$d of proglottis.
E	*H. gyogonka* sp. nov.	10	18–26	$\frac{1}{4}$:0.91	108–162	$\frac{1}{4}$—$\frac{1}{3}$ proglottis.

LITERATURE CITED

1. BACZYNSKA, H. Etudes anatomiques et histologiques sur quelques nouvelles especes de cestodes d'oiseaux. Bull. Soc. sci. nat. Neuchatel 40 (1914) 187–230.
2. FUHRMANN, O. Die Taenien der Raubvögel. Ctrbl. für Bakt. u. Parasit. 41 (1906) 79–89, 212–221.
3. FUHRMANN, O. Die Hymenolepisarten der Vögel. Ctrbl. für Bakt. u. Parasit. 41 (1906) 352–358, 440–462.
4. FUHRMANN, O. Cestodes d'oiseaux de la Nouvelle-Caledonie et des Îles Loyalty. F. Sarasin et J. Roux. Nova Caledonia Zoologie (14) 2 (1918) 399–443.
5. FUHRMANN, O. Die Cestoden der Deutschen Südpolar Expedition 1901–1903. Deutsche Südpolar Expedition 1901–1903. Zoologie (8) 16 (1921) 469–524.
6. FUHRMANN, O. Les tenias des oiseaux. Mem. Inst. Univ. Neuchatel 8 (1932) 1–381.
7. HSÜ, H. F. Contribution a l'etude des cestodes de Chine. Rev. Suisse Zool. 42 (1935) 477–570.
8. INAMDAR, N. B. Four new species of avian cestodes from India. Zeit. Parasit. 7 (1935) 192–206.
9. JOYEUX, C., and J. G. BAER. Notices helminthologiques. Ext. du Bull. de la Soc. Zool. de France 60 (1935) 482–501.
10. JOYEUX, C., and J. G. BAER. Faune de France (1936).
11. LINTON, E. Notes on cestode parasites of birds. Proc. U. S. Nat. Mus. 70 (1927) 1–75.
12. LÜHE, MAX. Parasitische Plattwürmer. II. Cestoda. Die Süsswasser-Fauna Deutschlands by Brauer (54) 18 (1910) 110.
13. MAYHEW, R. L. Studies on the avian species of the cestode family Hymenolepidae. Illinois Biol. Monographs 10 (1925) 1–125.
14. MEGGITT, F. J. The theory of host specificity as applied to cestodes. Ann. Trop. Med. Paras. Liverpool 28 (1934) 99–105.
15. SHIPLEY, E. A. On Drepanidotaenia hemignathi, a new species of tapeworm. Quart. Journ. Microsc. Sci. (n. s.) 40 (1898) 613–621.
16. SOUTHWELL, T., and F. LAKE. On a collection of Cestoda from the Belgian Congo. Ann. Trop. Med. Paras. Liverpool 33 (1939) 63–90.

ILLUSTRATIONS

TEXT FIGURES

[Legends: *cs*, cirrus sac; *ex ves sem*, external vesicula seminalis; *ov*, ovary; *rs*, receptaculum seminis; *rost*, rostellum; *suck*, sucker; *t*, testis; *v def*, vas deferens; *v l ex v*, *vit gl*, vitelline gland.]

MARINE PROTOZOA OF THE PHILIPPINES [1]

By Hilario A. Roxas

Of the Department of Zoology, University of the Philippines, Manila

SEVENTEEN PLATES AND TWO TEXT FIGURES

The general thesis that smaller plankton, both animal and vegetable, is practically the sole food of young marine fishes, has been proved beyond doubt by studies of the stomach contents of these animals. Plankton, likewise, serves as food for the adults of many species of fishes. Herrings, sardines, and mackerels are primarily plankton feeders. Even such large sea animals as the whales, and a number of sharks as well as many bivalves—the oysters, for example—subsist exclusively on plankton organisms.

Authorities estimate that nearly 90 per cent of commercial fishes have pelagic, that is, surface-floating eggs. Only in the rarest instances does a fish hatched from a buoyant egg ever grow large enough to descend to the bottom in the precise locality where the egg that gave it birth was spawned. After exhausting the yolk material of the egg, the young fish must rely on the microscopic plankton organisms available at its place of hatching for the continuation of its existence. It is, therefore, essential that we know the amount of surface plankton in our waters in order to determine the amount of pelagic fish life that it can sustain. No quantitative plankton studies, however, can be made without at least some sort of systematic qualitative studies. It is sad to admit that the Philippine seas are a *mare incognitum* as far as the microorganisms of the plankton are concerned.

The earliest work on the protozoa of the plankton in tropical Indo-Pacific waters was that of C. T. Cleve.(26) His material was collected by different individuals in 1897, 1899, and 1900 on a route from Aden to Java, a route from 45° south latitude 22° east longitude to 30° south latitude, and from the last point to 2° north latitude 94° east longitude; and in the Malay Archipelago, from Billiton to Timor. This work was followed by those of Weber Van Bosse,(102) Schmidt,(95) Schröder,(96) and Ostenfeld.(81) In later years Matzenauer(70) wrote on the dino-

[1] This article was submitted for publication in the Philippine Journal of Science while the author was chief of the Division of Fisheries, Department of Agriculture and Commerce, Manila.

flagellates of the Indian Ocean; Nielsen (76) and Böhm (12) wrote on the dinoflagellates of the south and western Pacific Ocean, while Marshall (69) wrote on the silicoflagellates and Tintinnoinea of the Great Barrier Reef. Lately Hada (44) made a comprehensive survey of the Tintinnoinea of the western tropical Pacific, obtaining his material from the Palao Islands, Yap, Saipan, Tinian, South China, Java, and Celebes. In spite, however, of several works on the marine protozoa of the tropical eastern, western, and southern Pacific, the China Sea, and the Indian Ocean, no work has been done on the protozoa of the seas in and immediately around the Philippines.

The present paper is a preliminary report on local marine protozoa, based on plankton material obtained weekly from the Bureau of Science Binakayan Experimental Station at Bacoor Bay (Manila Bay), and from one collection from the Marine Biological Station at Puerto Galera Bay, Mindoro. The study was originally undertaken with the end in view of determining the relationship between the rate of growth and fattening of oysters and the volume of planktonic organisms available from the water. Ultimately it is hoped to tie up the volume of planktonic organisms with the seasonal abundance and movement of herrings and sardines which are very important Philippine fisheries. The present report is not intended as a final work but merely as an invitation to other workers to collaborate in the huge task of solving our very numerous oceanographic and marine problems. Problems concerned with temperature, pressure, direction and force of wind, amount of rain, sunshine, clouds, specific gravity of the sea water, hydrogen-ion concentration, tides, currents, sediments, and turbidity of the water, as well as voluminous chemical, bacteriological, and botanical material, still await the attention, time, and energy of our scientists. All these data are needed if we would know the cause or causes of the distribution, abundance, and horizontal as well as vertical migration of plankton organisms and their effect on the seasonal distribution and abundance of the various fisheries.

Plankton collections were made with a townet of fine bolting cloth No. 20, of 176 mesh to the inch, from an outrigger banca. The plankton collected from each haul is transferred into a small wide-mouthed bottle with sufficient water and fixed in 10 per cent formalin solution. Qualitative studies are carried on in the laboratory.

The survey at Bacoor Bay and Puerto Galera Bay so far has yielded 68 species of marine protozoa. Of these 34 belong to the

order Dinoflagellida of the class Mastigophora (Flagellata), while 32 belong to the order Heterotrichida of the class Ciliata. The genera represented are, *Peridiniopsis*, 1 species; *Diplopeltopsis*, 1 species; *Goniaulux*, 2 species; *Peridinium*, 11 species; *Podolampas*, 1 species; *Ceratium*, 11 species; *Phalocroma*, 4 species; *Dinophysis*, 3 species; *Tintinnidium*, 3 species, two of them new; *Leprotintinnus*, 2 species, one of them new; *Tintinnopsis*, 10 species, two of them new; *Codonellopsis*, 1 species; *Coxliella*, 1 species; *Favella*, 4 species, three of them new; *Epiplocylis*, 3 species; *Metacylis*, 2 species, both new; *Petalotricha*, 1 species; *Rhabdonella*, 4 species, one of them new; *Tintinnus*, 1 species. These unicellular animals are the larger forms that do not readily pass through an ordinary silk bolting cloth and do not readily disintegrate soon after the haul. A large number of salt-water and brackish-water protozoa, however, are so minute and delicate that they have to be collected with the use of filter paper and treated with standard fixing agents soon after collection. Protozoa of the latter category have not yet been touched.

The protozoa, numerous and abundant as they are in our bays and seas, only rank second to the diatoms in importance as food for other aquatic animals and fishes. We are, therefore, hoping that in the near future our rich marine unicellular plant fauna will also attract the attention of our botanists.

SYSTEMATIC ENUMERATION OF PHILIPPINE MARINE PROTOZOA

Class Mastigophora
- Order Dinoflagellida
  - Family Peridiniidæ
    - *Peridiniopsis*
      - *Peridiniopsis asymmetrica* Mangin
    - *Diplopeltopsis*
      - *Diplopeltopsis minor* Lebour
    - *Goniaulux*
      - *Goniaulux polyedra* Stein
      - *Goniaulux digitale* Pouchet
    - *Peridinium*
      - *Peridinium conicoides* Paulsen
      - *Peridinium latissimum* Kofoid
      - *Peridinium leonis* Pavillard
      - *Peridinium subinerme* Paulsen
      - *Peridinium depressum* Bailey
      - *Peridinium divergens* Ehrenberg
      - *Peridinium obtusum* Karsten
      - *Peridinium venustum* Matzenauer
      - *Peridinium africanoides* Dangeard
      - *Peridinium curtipes* Jörgensen
      - *Peridinium pellucidum* (Bergh)

Class Mastigophora—Continued.
  Order Dinoflagellida—Continued.
    Family Peridiniidæ—Continued.
      Podolampas
        Podolampas bipes Stein
      Ceratium
        Ceratium furca (Ehrenberg)
        Ceratium candelabrum (Ehrenberg)
        Ceratium pentagonum Gourret
        Ceratium dens Ostenfeld & Schmidt
        Ceratium fusus (Ehrenberg)
        Ceratium tripos (O. F. Müller)
        Ceratium breve Ostenfeld & Schmidt
        Ceratium macroceros (Ehrenberg)
        Ceratium trichoceros (Ehrenberg)
        Ceratium contrarium Gourret
        Ceratium molle Kofoid
    Family Dinophysidæ
      Phalocroma
        Phalocroma rotundatum Claparéde & Lachmann
        Phalocroma cuneus Schütt
        Phalocroma mitra Schütt
        Phalocroma doryphorum Stein
      Dinophysis
        Dinophysis miles fo. *indica* Cleve
        Dinophysis caudata Kent
        Dinophysis hastata Stein
Class Ciliata
  Order Heterotrichida
    Family Tintinnididæ
      Tintinnidium
        Tintinnidium primitivum Busch
        Tintinnidium cylindrica sp. nov.
        Tintinnidium ampullarium sp. nov.
      Leprotintinnus
        Leprotintinnus nordquisti (Brandt)
        Leprotintinnus tubulosus sp. nov.
    Family Codonellidæ
      Tintinnopsis
        Tintinnopsis bacoorensis sp. nov.
        Tintinnopsis bütschlii Daday
        Tintinnopsis gracilis Kofoid & Campbell
        Tintinnopsis loricata Brandt
        Tintinnopsis manilensis sp. nov.
        Tintinnopsis major Meunier
        Tintinnopsis mortensenii Schmidt
        Tintinnopsis radix (Imhof)
        Tintinnopsis tocantinensis Kofoid & Campbell
        Tintinnopsis turgida Kofoid & Campbell

Class Ciliata—Continued.
Order Heterotrichida—Continued.
Family Codonellopsidæ
Codonellopsis
Codonellopsis ostenfeldi (Schmidt)
Family Coxliellidæ
Coxliella
Coxliella longa (Brandt)
Family Cyttarocylidæ
Favella
Favella simplex sp. nov.
Favella philippinensis sp. nov.
Favella elongata sp. nov.
Favella azorica (Cleve)
Family Ptychocylidæ
Epiplocylis
Epiplocysis exquisita (Brandt)
Epiplocylis ralumensis (Brandt)
Epiplocylis undella (Ostenfeld & Schmidt)
Family Petalotrichidæ
Metacylis
Metacylis hemisphærica sp. nov.
Metacylis kofoidi sp. nov.
Petalotricha
Petalotricha major Jörgensen
Family Rhabdonellidæ
Rhabdonella
Rhabdonella amor (Cleve)
Rhabdonella spiralis (Fol)
Rhabdonella brandti Kofoid & Campbell
Rhabdonella fenestrata sp. nov.
Family Tintinnidæ
Tintinnus
Tintinnus perminutus Kofoid & Campbell

Family PERIDINIIDÆ Kofoid

Theca of cell composed of epitheca, girdle, and hypotheca, all divided into plates. An apical pore usually present.

In the epitheca the plates around the apical portion are the apicals, and are usually designated in the descriptions by one accent mark (′); those just above the girdle are the precingulars, designated by two accent marks (″), while those between the precingulars and the apicals are the anterior intercalaries, designated by (*a*). These intercalaries never form a ccmplete series around the epitheca. The girdle may be composed of several girdle plates (*g*) or may be a single piece.

In the hypotheca the plates just below the girdle are the postcingulars (‴) and those at the abapical region are the anta-

pical plates (''''). Plates between the antapicals and postcingulars, called the posterior intercalaries (*p*), may be present.

A typical member of the Peridiniidæ has the following plate formula: 4 apicals, 3 anterior intercalaries, 7 precingulars, 5 postcingulars, no posterior intercalaries, and 2 antapicals; or in the abbreviated form: 4' 3*a* 7'' 5''' 0*p* 2''''.

Genus PERIDINIOPSIS Lemmermann (1904)

Cell spherical, conical, or lenticular. Plate formula: 3 apicals, 1 or 2 anterior intercalaries, 6 precingulars, 5 postcingulars, and 2 abapicals. Epitheca and hypotheca almost equal and with rounded sides. Girdle equatorial, not displaced and not excavate; provided with lists. First anterior intercalary diamond-shaped, between precingulars 2 and 3. Second anterior intercalary large, occupying almost half of epitheca.

Marine and fresh-water.

PERIDINIOPSIS ASYMMETRICA Mangin. Plate 1, figs. 1a, 1c, and 1d.

Peridiniopsis lenticula STEIN, Org. Infusionsthiere 3 (1883) 1–81, pl. 8, figs. 12–14; pl. 9, figs. 2–4.

Peridiniopsis asymmetrica MANGIN, Intern. Rev. Hydrobiol. 4 (1911); Nouv. Arch. Mus. Hist. Nat. 5 (1913); LEBOUR, Journ. Mar. Biol. Ass. 12 (1919–1922) 798, figs. 6–10; Dinoflagellates of Northern Seas (1925) 132, figs. 1–6; (1925) 101, pl. 15, figs. 3*a*–3*e*; MATZENAUER, Bot. Arch. 35 (1933) 453, figs. 24*a*–24*c*.

Small species. Body lens-shaped, symmetrical, wide, dorsally-ventrally slightly flattened. Longitudinal furrow with 2 spinelets, very shallow, not extending far toward center of hypotheca. Intercalary striæ very prominent and well visible. Test coarsely punctate. Cell contents pink.

Longest diameter 60 to 85 μ.

Common in Manila Bay.

Genus DIPLOPELTOPSIS Pavillard (1913)

Cell lens-shaped. Plate formula: 3 apical, 2 anterior intercalaries, 7 precingulars, 5 postcingulars, and 1 abapical.

Mostly marine and estuarine.

DIPLOPELTOPSIS MINOR Lebour. Plate 1, figs. 2a, 2c, and 2d.

Diplopsalis lenticula BERGH, Morph. Jahrb. 7 (1882) figs. 77*a*, 77*b*; SCHÜTT, Peridiniaceae 1 (1896) 21, fig. 31; OKAMURA, Annot. Zool. Japon. 6 (1906–1908) 131, pl. 5, fig. 44; PAULSEN, Nordisches Plankton 17 (1908) 36; Microplancton d'Alboran (1930) 40; LINDEMANN, Natürliche Pflanzenfamilien 2 (1928) 90, fig. 77; WANG and NIE, Cont. Biol. Lab. Sci. Soc. China 8 (1932) 296, fig. 9; MATZENAUER, Bot. Arch. 35 (1933) 453.

Diplopsalis sphærica MEUNIER, Campagne Arctique de 1907 1 (1910) 47, pl. 3, figs. 19, 22; Mem. Mus. Roy. d'Hist. Nat. 8 (1919) 64, pl. 19, figs. 1–12; pl. 20, figs. 1–4.

Diplopeltopsis minor LEBOUR, Journ. Mar. Biol. Ass. 12 (1919–1922) 801, figs. 11–15; 13 (1925) 102, pl. 15, figs. 2a–2e; LINDEMANN, Arch. f. Protist. 47 (1924) 133, figs. 11–15.

Small species with lens-shaped body. Epitheca and hypotheca subsimilar, both with rounded edges. Girdle circular, not displaced and not excavate. Longitudinal furrow with a list, deep, reaching near center of hypotheca. Small anterior intercalary on left side similar to that in *Peridiniopsis asymmetrica*, diamond-shaped between precingulars 2 and 3. Antapical plate single. Theca finely punctate. Cell contents more or less pinkish.

Cell about 53 μ in diameter and about 43 μ high.

Externally this species appears close to *Peridiniopsis asymmetrica*, but the longitudinal furrow is deep, and there is only one abapical plate instead of two.

Common in Manila Bay.

Genus GONIAULUX Diesing (1866)

Girdle equatorial, decidedly left-handed. Plates: apicals 3 to 5, anterior intercalaries 0 to 2, precingulars 6, postcongulars 6, posterior intercalary 1, antapical (1 or 3′ to 5′, 0 to 2*a* 6″ 1*p* 1‴′). First apical usually narrow, bearing a platelet covering apical pore, rest with numerous closely set pores.

GONIAULUX POLYEDRA STEIN. Plate 2, figs. 3c and 3d.

Goniaulux polyedra STEIN, Org. Infusionsthiere 3 (1883) pl. 4. figs. 7–9; SCHÜTT, Peridiniaceae (1896) 21, fig. 29; OKAMURA, Annot. Zool. Japon. 6 (1906–1908) 132, pl. 5, fig. 35; KOFOID, Univ. Cal. Pub. Zool. 8 (1911) 238, pl. 12, figs. 16–20; pl. 14, figs. 28, 29, 31; pl. 17, fig. 43; MEUNIER, Mem. Mus. Roy. d'Hist. Nat. 8 (1919) 70, 71, pl. 19, figs. 20–25; FAURÉ-FREMIET and PUIGAUDEAU, Bull. Soc. Zool. 47 (1922) 456–458, fig. 17; LEBOUR, Dinoflagellates Northern Seas (1925) 97, pl. 14, figs. 3a–3d; ABE, Sci. Rep. Tohoku Imp. Univ. 2 (1927) 390, fig. 8; PAULSEN, Micro. d'Alboran (1930) 38; MATZENAUER, Bot. Arch. 35 (1933) 451; CAMPBELL, Journ. Ent. Zool. 26 (1934) 18, fig. 4.

Small, angular, polyhedral, with ridges at sutures of plates. Girdle displaced 1 to 2 girdle widths. Surface finely porous. Plate formula 4′ 2*a* 6″ 6‴ 1*p* 1‴′. Fourth apical minute, anterior intercalaries ventral. Cell content deep brown.

Length about 60 μ.

Occasionally met with in Manila Bay.

GONIAULUX DIGITALE Pouchet. Plate 2, figs. 4a and 4d.

Goniaulux digitale POUCHET, J. Annot. Physiol. (1883) 433, pl. 18, fig. 14; KOFOID, Univ. Cal. Pub. Zool. 8 (1911) 214–217, pl. 9, figs. 1–5; FAURÉ-FREMIET and PUIGAUDEAU, Bull. Soc. Zool. 47 (1922) 454–455, fig. 15; LEBOUR, Dinoflagellates Northern Seas (1925) 92, 93, fig. 28*a*; PAULSEN, Microplancton d'Alboran (1930) 39.

Goniaulux spinifera STEIN, Org. Infusionsthiere 3 (1883) pl. 14, figs. 10–14.

Small species, slightly higher than wide. Epitheca subconical, with convex, at times angular sides. Girdle displaced 2.5 girdle widths. Epitheca with stout, blunt, apical horn, hypotheca with 2 strong antapical spines. Plate formula: 3′ 0*a* 6″ 6‴ 1*p* 1⁗. Theca strongly reticulate. Girdle list narrow but with strong spines.

Length 60 μ, diameter 50 μ.

Common in Manila Bay.

Genus PERIDINIUM Ehrenberg (1832)

Cell cone-shaped, egg-shaped, or flattened. Apex usually with a distinct apical pore and apical horn. Plate formula: 4 apicals, 2 or 3 anterior intercalaries, 7 precingulars, 5 postcingulars, and 2 abapicals.

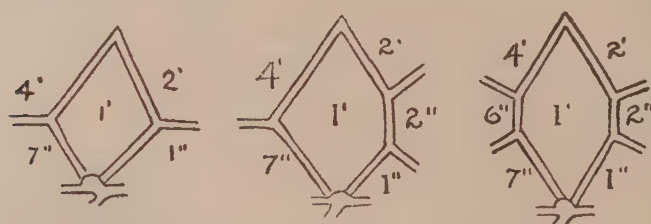


FIG. 1. Number of intercalaris and their relation to the precingulars in the groups *Orthoperidium*, *Metaperidinium*, and *Paraperidinium*.

The classification of this genus is based primarily on the character of the first apical and second anterior intercalary. On the basis of the first apical the members of the genus can be grouped into *Orthoperidinium*, *Metaperidinium*, and *Paraperidinium*. In the group *Orthoperidinium* the first apical plate is diamond-shaped and is bounded by the first and seventh precingulars and the second and fourth apicals (text fig. 1).

In the group *Metaperidinium* the first apical is pentagonal and is bounded by the first, second, and seventh precingulars and by the second and fourth apicals. In *Paraperidinium* the first

apical is hexagonal and is bounded by the first, second, sixth, and seventh precingulars and by the second and fourth apicals.

The genus *Peridinium* has been divided by authors into two subgenera: *Archæperidinium,* in which there are only two anterior intercalaries, and *Peridinium* proper, in which there are three. In the latter the second anterior intercalary may be touching the fourth and fifth, the third and fourth, the third, fourth, and fifth precingulars, or only the fourth precingular. These various relationships are indicated in text fig. 2.

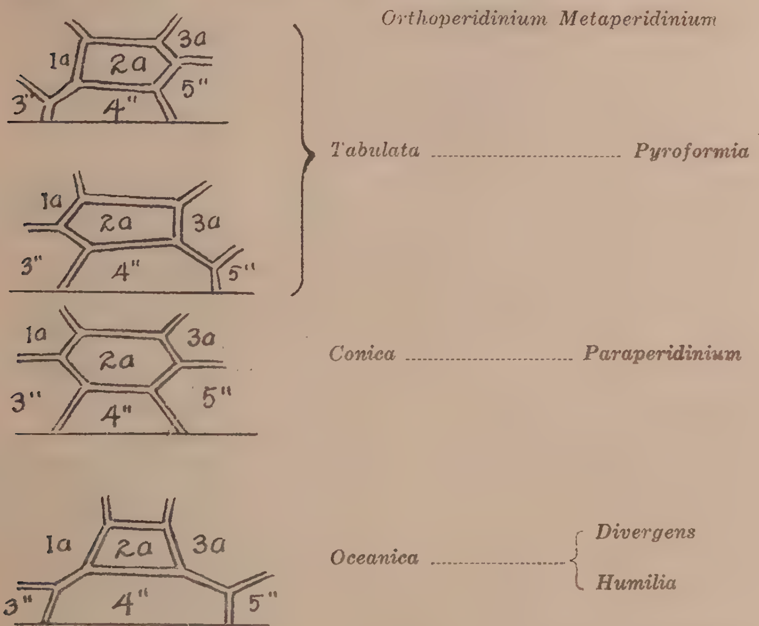


FIG. 2. Number of intercalaries and their relation to the precingulars in the subgenera of *Peridinium.*

Group ORTHOPERIDINIUM

Section CONICA

In § *Conica* the second anterior intercalary touches precingulars 3, 4, and 5.

PERIDINIUM CONICOIDES Paulsen. Plate 3, figs. 6a to 6d.

Peridinium conicoides PAULSEN, Medd. Komm. Havunders. Kopenhagen ser. plankton 1 (1905) 3, fig. 2; MEUNIER, Campagne Arctique de 1907 1 (1910) 39, pl. 1, figs. 31, 34; Mem. Mus. Roy. d'Hist. Nat. 8 (1919) 40, 41, pl. 17, figs. 23–31; LEBOUR, Dinoflagellates Northern Seas (1925) 112, pl. 20, figs. 2*a*–2*d*.

Cell almost symmetrical, dorsoventrally slightly flattened. Sides of epitheca and hypotheca straight or slightly convex. Girdle almost circular, slightly left-handed. Hypotheca with two small hollow antapical spines. Longitudinal groove prominent, extending to beyond center of hypotheca. Theca finely reticulate. A small platelet at apical pore. Cell content yellowish. Cell about 60 μ high and 62.9 μ in diameter.

Common in Manila Bay.

PERIDINIUM LATISSIMUM Kofoid. Plate 3, figs. 7a to 7e.

Peridinium latissimum KOFOID, Bull. Mus. Comp. Zool. 1 (1907) MATZENAUER, Bot. Archiv 35 (1933) 456, figs. 30*a*–30*e*.

Peridinium pentagonium fo. *depressum* ABE, Sci. Rep. Tohoku Imp. Univ. 2 (1927) 409, fig. 29.

Peridinium depressum PAVILLARD, Resultats Campagnes Scientifiques 82 (1931).

Cell pentagonal in ventral and dorsal views, asymmetrical in apical view, right side more or less larger than left. Epitheca conical, with straight sides and a distinct apical pore. Girdle left-handed, greatly excavate, with list. Hypotheca also with straight sides. Abapical boundary concave, with two solid inconspicuous spines. Longitudinal furrow shallow, not reaching center of hypotheca. Test very finely reticulate. Contents more or less pinkish.

Length about 20 μ, breadth about 58 to 60 μ.

This species differs from *P. pentagonum* Gran (1902) in being dorsoventrally more flattened and in having a more concave boundary between the two abapical horns. Similar to *P. pentagonum* in the line separating the anterior and posterior halves of the epitheca being straight and the cell asymmetrical.

Common in Manila Bay during June and July.

PERIDINIUM LEONIS Pavillard. Plate 4, figs. 8a to 8e.

Peridinium leonis PAVILLARD, Trav. Inst. Bot. 4 (1916) LEBOUR, Dinoflagellates Northern Seas (1925) 112, pl. 21, figs. 1*a*–1*d*; PAULSEN, Microplancton d'Alboran 4 (1930) 70, fig. 41; MATZENAUER, Bot. Archiv 35 (1933) 456, figs. 29*a*–29*c*; BÖHM, Bull. B. P. Bishop Mus. 137 (1936) 44.

Cell more or less pentagonal in ventral and dorsal views, but with a concave abapical side. Epitheca conical, with more or less straight sides. Girdle slightly left-handed, almost circular with a slight anterior excavation. Longitudinal groove wide, with almost straight sides. A small spinelet present at end of left side of longitudinal groove. Hypotheca with straight sides, and two pointed abapical lobes each terminating in a solid spine.

Theca reticulate and spiny, on epitheca appearing as if with more or less parallel lines. Cell contents pink.

Cell about 70 μ high and 65 μ in diameter.

Very close to *P. latissimum* and *P. pentagonum* in general shape. Differs from *P. latissimum* in having the line separating the anterior and posterior halves rugged instead of straight. Unlike the case in *P. conicum* and *P. pentagonum,* the lines separating Plates 1′, 1″ and 7″, 2′ and 2″ on one side and from 4′ and 6″ on the other are in the form of a zigzag instead of straight.

Common in Manila Bay.

PERIDINIUM SUBINERME Paulsen. Plate 4, figs. 9a to 9d.

Peridinium subinerme PAULSEN, Medd. Komm. Havunders. Kopenhagen 1 (1904) 24, fig. 10; (1907) 18, figs. 26, 27; Microplancton d'Alboran 4 (1930) 71, fig. 42; FAURÉ-FREMIET and PUIGAUDEAU, Bull. Soc. Zool. 47 (1922) 451–452, fig. 13.

Peridinium subinermis BROCH, Planktonstudien Mündung Ostsee (1908) 54, fig. 28; MEUNIER, Duc D'Orleans Campagne Arctique de 1907 8 (1910) 40, pl. 2, figs. 43, 44; Mem. Mus. Roy. d'Hist. Nat. 8 (1919) 43, pl. 17, figs. 36–40; LEBOUR, Dinoflagellates Northern Seas (1925) 114, pl. 22, figs. *2a–2f;* MATZENAUER, Bot. Archiv 35 (1933) 457; BÖHM, Bull. B. P. Bishop Mus. 137 (1936) 44, fig. 16*a*.

Cell small, epitheca more or less conical with slightly convex sides. Girdle circular, not excavate, not displaced. Hypotheca with convex sides, with a contour appearing more or less like an inverted helmet. Longitudinal furrow wide, terminating in two tiny spinelets as seen from above, apical pore off center, towards right side, plates on this side of epitheca smaller than those on left. Intercalary striæ sometimes broad. Cell contents pink. Theca finely reticulated.

Cell about 45 μ high and 56 μ in diameter.

Common in Manila Bay.

Section OCEANICA

In § *Oceanica* the second anterior intercalary touches the fourth precingular plate.

PERIDINIUM DEPRESSUM Bailey. Plate 5, figs. 10a to 10d.

Peridinium depressum BAILEY, Smith. Contr. Knowl. 7 (1855) 12, figs. 33, 34; SCHÜTT, Natürliche Pflanzenfamilien 1 (1896) 13, fig. 16; BROCH, NYT Mag. f. Natur. 44 (1906) 151, fig. 1; Planktonstudien Mündung Ostsee (1908) 52; PAULSEN, Nordisches Plankton 17 (1908) 53; Microplancton d'Alboran (1930) 68; PAVILLARD, Bull. Soc. Bot. 56 (1909) 281; OKAMURA, Rep. Imp. Bur. Fish 1 (1912) pl. 4, figs. 60–62; FAURÉ-FREMIET and PUIGAUDEAU, Bull. Soc. Zool.

47 (1922) 441–443, fig. 8; LEBOUR, Dinoflagellates Northern Seas (1925) 119, figs. 23*a*–23*f*; MATZENAUER, Bot. Archiv 35 (1933) 422, fig. 43; BÖHM, Arch. f. Protist. 80 (1933) 311, figs. 5*a*, 5*b*; Bull. B. P. Bishop Mus. 137 (1936) 42, 45, 46, fig. 17*b*; CAMPBELL, Journ. Ent. Zool. 26 (1934) 18, fig. 7.

Large species with short but broad cell; epitheca symmetrical with sides decidedly concave, provided with a well-developed and conspicuous apical horn and apical pore. Girdle projecting, left-handed, with prominent lists supported by transverse spinelets. Right antapical lobe larger than left. Both antapical horns terminating in spine and each provided on inner side with a tooth continuous with each side of longitudinal furrow. Theca finely reticulate. Cell contents light pink. Globules yellowish pink.

Cell about 142 μ in diameter and about 178 μ long.

Most common in Manila Bay in June.

Section DIVERGENS

First apical pentagonal; second intercalary touching precingular 4 only.

PERIDINIUM DIVERGENS Ehrenberg. Plate 7, figs. 14a, 14b, and 14d.

Peridinium divergens EHRENBERG, Monatsber. Akad. Wiss. (1854) 240, pl. 35*a*, fig. 24*b*; STEIN, Org. Infusionsthiere (1883) pl. 10, figs. 1–9; pl. 11, figs. 1, 2; SCHÜTT, Natürliche Pflanzenfamilien 1 (1896) 22, fig. 32; MURRAY and WHITTING, Trans. Linn. Soc. 5 (1899) 326, pl. 29, fig. 4; KARSTEN, Wiss. Ergeb. d. Deuts. Tief.-Exp. 2 (1907) 416, pl. 50, figs. 8, 10*a*–10*c*, 11; pl. 52, figs. 4*a*, 4*b*, 5*a*, 5*b*; pl. 53, figs. 1–3, 6*a*, 6*b*; FAURÉ-FREMIET, Ann. Sci. Natur. 7 (1908) 271; PAVILLARD, Bull. Soc. Bot. 56 (1909) 280; MEUNIER, Duc. D'Orleans Campagne Arctique 2 (1910) 23, pl. 1, figs. 1–4; pl. 2, figs. 45, 46; Mem. Mus. Roy. d'Hist. Nat. 8 (1919) 12–14, pl. 15, figs. 1–5; FAURÉ-FREMIET and PUIGAUDEAU, Bull. Soc. Zool. 47 (1922) 455–447, fig. 10; LEBOUR, Dinoflagellates Northern Seas (1925) 127, pl. 26, figs. 2*a*–2*e*; LINDEMANN, Natürliche Pflanzenfamilien 2 (1928) 13, figs. 2, 4; PAULSEN, Microplancton d'Alboran (1930) 63; WANG and NIE, Cont. Biol. Lab. Sci. Soc. 8 (1932) 290, figs. 1–2; MATZENAUER, Bot. Archiv 35 (1933) 466; CAMPBELL, Journ. Ent. Zool. 26 (1934) 18, fig. 8.

Cell from ventral view more or less pentagonal. Epitheca with convex sides abruptly straightening apically to form a distinct apical lobe. Girdle slightly right-handed, almost circular with a slight concavity on ventral side. Transverse groove with prominent lists. Hypotheca with more or less convexoconcave sides terminating in two hollow abapical spines. Longitudinal groove prominent, extending to center of hypotheca, with lists.

Test prominently reticulated with tiny spinelets at junction of reticulation. Cell contents pinkish, turning greenish yellow in formalin.

Length about 90 to 95 μ, breadth about 56 μ. The dominant form of *Peridinium* in Bacoor Bay (a part of Manila Bay) toward the end of July.

PERIDINIUM OBTUSUM Karsten. Plate 5, figs. 11a–11d.

Peridinium obtusum KARSTEN, Deuts. Tief.-Exp. 2 (1906); FAURÉ-FREMIET, Ann. Sci. Natur. 7 (1908) 233, fig. 9; LEBOUR, Dinoflagellates Northern Seas (1925) 121, pl. 24, figs. *2a–2d;* CAMPBELL, Journ. Ent. Zool. 26 (1934) 18, fig. 10.

Cell small, more or less pentagonal in ventral view, but with concave abapical side. Epitheca with almost straight sides. Girdle not displaced or only very slightly left-handed and hardly excavate. Longitudinal furrows reaching well to the hypotheca with one small spine on each side at abapical region. Hypotheca also with straight sides, two shallow antapical horns terminating in spines which project more or less laterally. Theca more or less spiny. Cell contents pink.

Cell about 60 μ high and 70 μ in diameter.

Common in Manila Bay.

PERIDINIUM VENUSTUM Matzenauer. Plate 6, figs. 12a, 12b, 12d, and 12e.

Peridinium venustum MATZENAUER, Bot. Archiv 35 (1933) 464, fig. 45; BÖHM, Bull. B. P. Bishop Mus. 137 (1936) 45.

Cell thin, much flattened in anteroposterior direction. Epitheca appearing on ventral and dorsal view as a regular concave cone. Apical pore elongate. Hypotheca also with concave sides and two hollow abapical horns. Transverse girdle slightly left-handed, much higher on dorsal side than on ventral. Longitudinal groove with a spinelet on each side at its junction with abapical horns. First apical diamond-shaped, of the *Orthoperidinium* type, second anterior intercalary of *Oceanica* type, touching only fourth precingular. Contents light pink, turning greenish-yellow with long preservation in formalin. Theca thin, with fine, widely separate pores.

Length 103 μ, diameter 78 μ.

Quite common in Manila Bay during July.

Group METAPERIDINIUM

Section PYROFORMIA

First apical pentagonal; second anterior touching precingulars 3 and 4 or 4 and 5.

PERIDINIUM AFRICANOIDES Dangeard. Plate 6, figs. 13a, 13c, and 13d.

Peridinium africanoides DANGEARD, Ann. L'Inst. Oceanog. (1927); MATZENAUER, Bot. Archiv 35 (1933) 460, fig. 39; BÖHM, Bull. B. P. Bishop Mus. 137 (1936) 41, fig. *b*1, *b*2.

Body pear-shaped; at times slightly angular, theca with a finely reticulated surface. Epitheca with an elongate, prominent, apparently open apical horn. Girdle with prominent lists supported by transverse spines. Hypotheca with two prominent and winged antapical spines. Striæ quite prominent and wide between postcingulars and apical plates. Cell contents in life light pink.

This form is exceptional in having 4 anterior intercalaries instead of the usual 3.

Cell with a total length of about 100 μ and a diameter of around 85 μ.

Common in Manila Bay.

PERIDINIUM CURTIPES Jörgensen. Plate 7, figs. 15a to 15d.

Peridinium curtipes JÖRGENSEN, Skr. Schw. Hydrog.-biol. Komm. 4 (1912); LEBOUR, Dinoflagellates Northern Seas (1925) 128, fig. 39; PAULSEN, Microplancton d'Alboran (1930) 64; MATZENAUER, Bot. Archiv 35 (1933) 468, figs. 52*a*, 52*b*.

Peridinium crassipes PAULSEN, Medd. Komm. Havunders. 1 (1907) 27, fig. 24; Nordisches Plankton 17 (1908) 48, fig. 73; Microplancton d'Alboran (1930) 65, fig. 36; KOFOID, Univ. Cal. Pub. Zool. 3 (1907) 309, pl. 31, figs. 46, 47; FAURÉ-FREMIET, Ann. Sci. Natur. 7 (1908) 218, pl. 16, fig. 17; BROCH, Arch. f. Protist. 20 (1910) 193–195, figs. 9–10; OKAMURA, Rep. Imp. Bur. Fish 1 (1912) pl. 4, fig. 63; FAURÉ-FREMIET and PUIGAUDEAU, Bull. Soc. Zool. 47 (1922) 447, 448, fig. 11; DANGEARD, Ann. L'Inst. Oceanog. (1927) 324, figs. 18*a*–18*c*; MATZENAUER, Bot. Archiv 35 (1933) 467, figs. 50*a*–50*d*; CAMPBELL, Journ. Ent. Zool. 26 (1934) 18, fig. 6.

Cell broad but short. Epitheca conical, with distinctly concave sides. Girdle almost spherical, only slightly excavate at ventral side. Transverse furrow with prominent lists supported by spines. Longitudinal furrow narrow. Hypotheca with convexoconcave sides. Abapical region with two horns terminating in small spines. Inner side of horns with prominences and small spines. Left horn larger and wider than right. Theca finely reticulate and with very fine pores. First apical plate pentagonal, second anterior intercalary touching only precingular 4. Thus this species belongs to the *Metaperidinium divergens* type. Cell contents yellowish green.

Length about 85 μ, diameter about 90 μ.

Common in Manila Bay.

Section PARAPERIDINIUM

First apical hexagonal; second anterior intercalary touching precingulars 3, 4, and 5.

PERIDINIUM PELLUCIDUM (Bergh). Plate 8, figs. 16a to 16d.

Protoperidinium pellucidum BERGH, Morph. Jahrb. 7 (1881) 227, figs. 46–48.

Peridinium pellucidium SCHÜTT, Ergeb. Plankton Exped. 4 (1895) 45; PAULSEN, Nordisches Plankton 17 (1908) 49, fig. 61; Microplancton d'Alboran (1930) 56; BROCH, Planktonstudien Mündung Ostsee (1908) 44, 45, figs. 15, 16; Arch. f. Protist. 20 (1910) 188, 189, fig. 6; FAURÉ-FREMIET, Ann. Sci. Natur. 7 (1908) 219–221, pl. 15, fig. 9; text figs. 6, 7; MEUNIER, Duc D'Orleans Campagne Arctique 1 (1910) 30, pl. 1, figs. 26–28; Mem. Mus. Roy. d'Hist. Nat. 8 (1919) 21–23, pl. 15, figs. 30–42; PAVILLARD, Mem. Trav. Inst. Bot. Univ. Montpellier 4 (1916) 38; LEBOUR, Dinoflagellates Northern Seas (1925) 23, fig. 2; MATZENAUER, Bot. Archiv 35 (1933) 461, figs. 42a–42c.

Small species with epitheca more or less pointed. Epitheca and hypotheca with decidedly convex sides. Girdle almost circular in cross section, slightly right-handed. Longitudinal furrow with one right and two left antapical spines. Striæ quite prominent. Theca finely reticulate. First apical plate 5-sided, second apical intercalary 6-sided as stated by Matzenauer.(70)

Cell about 43 μ in diameter and 53 μ high.

Genus PODOLAMPAS Stein (1883)

Cell pear-shaped, drawn out apically into an apical horn with a prominent apical pore. Girdle absent. Two strong antapical spines with transverse wings present. Plate formula: apicals 2, anterior intercalary 1, precingulars 6, postcingulars 3, antapicals 4 (′′′ 1*a* 6″ 3‴ 4⁗).

PODOLAMPAS BIPES Stein (1883). Plate 2, figs. 5a and 5b.

Podolampas bipes STEIN, Org. Infusionsthiere (1883) pl. 8, figs. 6–9; SCHÜTT, Natürliche Pflanzenfamilien 1 (1896) 23, fig. 33; MURRAY and WHITTING, Trans. Linn. Soc. 5 (1899) 328; KOFOID, Arch. f. Protist. 16 (1909) 55–58; OKAMURA, Rep. Imp. Bur. Fish 1 (1912) pl. 2, fig. 37; LEBOUR, Dinoflagellates Northern Seas (1925) text-fig. 52*b*; LINDEMANN, Natürliche Pflanzenfamilien 2 (1928) 100, 101, fig. 87; PAULSEN, Microplancton d'Alboran (1930) 74; MATZENAUER, Bot. Archiv 35 (1933) 482.

Cell broadly pear-shaped, with a short apical horn. Antapical spines about equal, wings not fused. Intercalary striæ very wide.

Cell about 92 μ long, 65 μ in greatest diameter.

Occasionally met with in Manila Bay.

Genus CERATIUM Schrank (1793)

Cell dorsoventrally flattened. Transverse furrow usually equatorial, girdle left-handed. Longitudinal furrow usually very wide, occupying a large portion of the ventral surface of the body. Epitheca with one apical horn terminating at an apical pore. Hypotheca with two abapical hollow horns which are open or closed at the end. Test thick, reticulate or striped, with numerous tiny pores. Boundaries of cell plates indistinct. Plate formula 4′ 5″ 5‴ 2⁗.

Subgenus BICERATIUM Gran

With one apical horn and two (rarely three) abapical horns normally closed at tips and directly backward. Right hind horn smaller, rarely shorter than half the left. Epitheca, including horn, much longer than hypotheca.

CERATIUM FURCA (Ehrenberg). Plate 8, figs. 17a and 17b.

Peridinium furca EHRENBERG, Infusionsthierchen als vollkommene Organismen 18 (1838) 256, pl. 22, fig. 21.

Ceratium furca CLAPARÉDE and LACHMANN, Mem. Inst. Nat. Geneve 6 (1859) 399, pl. 19, fig. 5; STEIN, Org. Infusionsthiere (1883) pl. 15; figs. 7–14, pl. 25; CLEVE, Kongl. Sv. Vet.-Akad. Handl. 32 (1899) 36; (1) 34 (1900) 19; (2) 34 (1900) 20; Öfv. Kongl. Sv. Vet.-Akad. Förhandl. (9) 57 (1900) 1030; Kongl. Sv. Vet.-Akad. Handl. (5) 35 (1901) 13; (7) 35 (1902) 24; SCHRÖDER, Mitt. Zool. Stat. Neapel 14 (1901) 17; OSTENFELD and SCHMIDT, Vidensk. Medd. 52 (1901) 163; OKAMURA and NISHIKAWA, Annot. Zool. 5 (1904) 126, pl. 6, fig. 15; JOLLOS, Arch. f. Protist. 19 (1910) 193, pl. 9, fig. 54; OKAMURA, Rep. Imp. Bur. Fish 1 (1912) 7; MEUNIER, Mem. Mus. Roy. d'Hist. Nat. (1919) 85, pl. 20, figs. 30–32; LEBOUR, Dinoflagellates Northern Seas (1925) 145, pl. 30, fig. 3; PAULSEN, Microplancton d'Alboran (1930) 76, fig. 46; BÖHM, Bull. B. P. Bishop Mus. 87 (1931) 8–13, figs. 4–8; WANG and NIE, Cont. Biol. Lab. Sci. Soc. 8 (1932) 297, figs. 10, 11; NIELSEN, Dana Exp. Rep. 4 (1934) 9, fig. 849; CAMPBELL, Journ. Ent. Zool. 26 (1934) 21, fig. 15.

Epitheca longer than hypotheca, evenly narrowing into an open apical horn of medium length. Hypotheca shorter than epitheca, with two more or less parallel, pointed, closed, antapical horns. Right antapical horn about half as long as left, both more or less toothed at sides. With deep yellow chromatophores.

Total length, 150 to 160 μ; greatest breadth, 33 to 37 μ.

Common in Manila Bay.

CERATIUM CANDELABRUM (Ehrenberg). Plate 8, fig. 18a.

Peridinium candelabrum EHRENBERG, Monatsber. der Berliner Akad. d. Wiss. (1859).

Ceratium candelabrum STEIN, Org. Infusionsthiere (1883) pl. 16, figs. 15, 16; OSTENFELD and SCHMIDT, Vidensk. Medd. 52 (1901) 163; CLEVE, Ark. f. Zool. 1 (1903) 340; OKAMURA, Rep. Imp. Bur. Fish 1 (1912) 7; LEBOUR, Dinoflagellates Northern Seas (1925) 143, pl. 30, fig. 2, text figs. 45*b*, 45*c*; BÖHM, Arch. f. Protist. (1931) 351, 367, text figs. 1, 2, 24; Bull. B. P. Bishop Mus. 81 (1931) 8, fig. 3; PAVILLARD, Prince Monaco Res. Camp. Sci. 82 (1931) 68, pl. 2, figs. 16*a*–16*d*; NIELSEN, Dana Exp. Rep. 4 (1934) 8, figs. 6, 7.

Epitheca longer than hypotheca; abruptly narrowing (90°) to form a stout, long, open, apical horn. Hypotheca with two more or less parallel or slightly divergent horns close to their tips. Right antapical horn shorter but very much more than half of left.

Total length, about 265 μ; greatest width, about 76 μ; apical horn, 180 μ; right antapical horn, 48 μ; left antapical horn, about 65 μ.

Found in Puerto Galera Bay, Mindoro, during April.

CERATIUM PENTAGONUM Gourret. Plate 8, figs. 19a and 19b.

Ceratium pentagonum GOURRET, Ann. Mus. d'Hist. Nat. Zool. 5 (1881) 45, tab. 4, fig. 58; OKAMURA, Rep. Imp. Bur. Fish 1 (1912) 8, pl. 3, fig. 50; BÖHM, Arch. f. Protist. (1931) 352; Bull. B. P. Bishop Mus. 87 (1931) 12, fig. 9*b*; PAVILLARD, Prince Monaco Res. Camp. Sci. 82 (1931) 71; NIELSEN, Dana Exp. Rep. 4 (1934) 11, fig. 12.

Ceratium lineatum var. *robusta* CLEVE, Öfv. Kongl. Sv. Vet.-Akad. Forhandl. 57 (1900) 925, fig. 6.

Ceratium lineatum var. *longiseta* OSTENFELD and SCHMIDT, Vidensk. Medd. 52 (1901) 163, fig. 12; CLEVE, Ark. f. Zool. 1 (1903) 341; OKAMURA, Annot. Zool. Japon. 6 (1907) 127, pl. 3, fig. 7*a*.

Ceratium lineatum OSTENFELD and SCHMIDT, Vidensk. Medd. 52 (1901) 163.

Epitheca only slightly greater than hypotheca. Epitheca converging to about 80° and giving rise to a slender, weak-looking, apical horn. Hypotheca short, provided with two parallel, weak-looking, pointed, close, antapical horns. Right antapical greater than one half of left.

Total length about 265 μ; greatest diameter about 55 μ.

Found in Puerto Galera Bay, Mindoro.

CERATIUM DENS Ostenfeld and Schmidt. Plate 9, fig. 20a.

Ceratium dens OSTENFELD and SCHMIDT, Vidensk. Medd. 52 (1901) 165, text fig. 16; CLEVE, Ark. f. Zool. 1 (1903) 340; KARSTEN, Wiss. Ergeb. Deuts. Tief.-Exp. 2 (1907) 414, pl. 48, figs. 8*a*, 8*b*; BÖHM, Bull B. P. Bishop Mus. 87 (1931) 15, fig. 11; NIELSEN, Dana Exp. Rep. 4 (1934) 15, fig. 27.

Epitheca less than hypotheca. Epitheca converging to about 85° to produce a strong apical horn open at the tip. Hypotheca diverging, with two antapical horns both closed at the tip. Left antapical short, about 36 μ long, directed more or less laterally. Right antapical more than twice as long, about 80 μ, directed anteriorly, making an angle of about 75° with body wall.

Total length about 190 μ; body about 60 μ long, 60 μ in diameter.

Found in Puerto Galera Bay, Mindoro.

Subgenus AMPHICERATIUM Vanhöffen

Cell long and narrow, only slightly, if at all, dorsoventrally flattened. Right posterior horn rudimentary or absent. Horns normally closed at tips.

CERATIUM FUSUS (Ehrenberg). Plate 9, figs. 21a and 21b.

Peridinium fusus EHRENBERG, Infusionsthierchen als vollkommene Organismen **18** (1838) 256, pl. 22, fig. 20.

Ceratium fusus CLAPARÈDE and LACHMANN, Mem. Inst. Nat. **6** (1859) 400, pl. 19, fig. 7; STEIN, Org. Infusionsthiere (1883) 15, figs. 1–6; CLEVE, Kongl. Sv. Vet.-Akad. Handl. (3) **32** (1899) 36; (8) **32** (1900) 19; (2) **34** (1900) 20; Öfv. Kongl. Sv. Vet.-Akad. Förhandl. (9) **57** (1900) 1030; (5) **35** (1901) 14; (7) **35** (1902) 24; AURIVILLUS, Kongl. Sv. Vet.-Akad. Handl. (6) **32** (1899) 31; SCHRÖDER, Mitt. Zool. Stat. Neapel **14** (1901) 17; OSTENFELD and SCHMIDT, Vidensk. Medd. **52** (1901) 164; JOLLOS, Arch. f. Protist. **19** (1910) 193, pl. 9, fig. 53; MEUNIER, Mem. Mus. Roy. d'Hist. Nat. **8** (1919) 89, pl. 21, figs. 1, 2; LEBOUR, Dinoflagellates Northern Seas (1925) 146, pl. 31, fig. 1; PAULSEN, Microplancton d'Alboran (4) (1930) 77; BÖHM, Arch. f. Protist. (1931) 355; Bull. B. P. Bishop Mus. **87** (1931) 14, fig. 10, *c–f;* NIELSEN, Dana Exp. Rep. **4** (1934) 14, figs. 25, 26; CAMPBELL, Journ. Ent. Zool. **26** (1934) 21, fig. 16.

Epitheca long, regularly narrowing into a long, evenly wide apical horn, often with a tiny knot at tip. Apical horn straight or weakly bent dorsally. Hypotheca with a long left antapical horn not quite as long as the apical horn, and a tiny, very short, rudimentary right horn. Both closed at tips.

Total length, about 278 μ; greatest breadth, about 19 μ.

Common in surface plankton, Manila Bay.

Subgenus EUCERATIUM Gran

Cell broad and flattened, usually anchor-shaped; with two anteriorly directed posterior horns.

Horn normally closed at tip.

CERATIUM TRIPOS (O. F. Müller). Plate 9, figs. 22a and 22b.

Cercaria tripos O. F. MÜLLER, Zool. danicae prodromus (1777); (1871) 206.

Ceratium tripos NITZSCH, Neue Schriften d. Naturf. Ges. zu Halle 3 (1817) 4; CLAPARÉDE and LACHMANN, Mem. Inst. Nat. Geneve 6 (1859) 396, pl. 19, figs. 1–4; STEIN, Org. Infusionsthiere (1883) pl. 16, figs. 1–11; CLEVE, Kongl. Sv. Vet.-Akad. Handl. (3) 32 (1899) 36; (8) 32 (1900) 19; (1) 34 (1900) 21; (5) 35 (1901) 14; (7) 35 (1902) 25; SCHRÖDER, Mitt. Zool. Stat. Neapel 14 (1901) 15, pl. 1, fig. 17; OKAMURA and NISHIKAWA, Annot, Zool. Japon. 5 (1904) 121, pl. 6, fig. 1; KARSTEN, Wiss. Ergeb. d. Deuts. Tief.-Exp. 2 (1907) 404; PAVILLARD, Bull. Soc. Bot. 54 (1907) 153; JOLLOS, Arch. f. Protist. 19 (1910) 193, pl. 9, fig. 52; LEBOUR, Journ. Mar. Biol. Ass. 11 (1917) 187, fig. 1; Dinoflagellates Northern Seas (1925) 125, pls. 32*a*–32*c*, 33; text figs. 46*b*–46*d*; MEUNIER, Mem. Mus. Roy. d'Hist. Nat. pt. 3 8 (1919) 83, pl. 20, figs. 27–29; BIGELOW, Bull. U. S. Bur. Fish 40 (1924) 407, figs. 113, 114; LINDEMANN, Natürliche Pflanzenfamilien 2 (1928) 27, figs. 8*a*–8*c*; PAULSEN, Microplancton d'Alboran (1930) 79, fig. 47; BÖHM, Arch. f. Protist. (1931) 15, fig. 12; WANG and NIE, Cont. Biol. Lab. Sci. Soc. 8 (1932) 302, figs. 16, 17; NIELSEN, Dana Exp. Rep. 4 (1934) 17, figs. 32, 33.

Fairly large species with cell anchor-shaped, broad, more or less flattened. Epitheca shorter than wide, with an anterior horn of more or less uniform diameter. Hypotheca with an oblique, but slightly convex posterior border. Right side of hypotheca about 6 or 7 times as great as left side. Antapical horns both pointed and closed at tip, right antapical horn making a more acute angle with the cell body than left. Theca provided with prominent, anastomosing ridges and numerous tiny pores. With greenish-yellow chromatophores.

Cell about 67 μ long, 67 μ wide; total length about 210 μ.

Common in Manila Bay.

CERATIUM BREVE Ostenfeld and Schmidt. Plate 10, fig. 23a.

Ceratium tripos var. *brevis* OSTENFELD and SCHMIDT, Vidensk. Medd. 52 (1901) 164, fig. 13.

Ceratium breve var. *parallelum* OKAMURA, Rep. Imp. Bur. Fish 1 (1912) 9, fig. 86.

Ceratium breve DANGEARD, Ann. L'Inst. Oceanog. (1927) 376; BÖHM, Bull. B. P. Bishop Mus. 87 (1931) 18, fig. 18; WANG and NIE, Cont. Biol. Lab. Sci. Soc. 8 (1932) 306, fig. 19; NIELSEN, Dana Exp. Rep. 4 (1934) 18, figs. 35, 36.

Fairly large specimen with epitheca longer but much narrower than hypotheca. Left side of hypotheca several times as great as right side. Antapical horns pointed, close, very prominent,

directed more or less anteriorly, their bases making an obtuse angle (90° to 105°) with the sides of the hypotheca. Anterior border of these horns for the greatest part of their length prominently ribbed. Horns normally open at tips.

Total length with apical horn, 132 μ; greatest width, 62 μ; right abapical horn about 100 μ; left abapical horn, about 190 μ.

Occasionally met with in Puerto Galera Bay, Mindoro.

CERATIUM MACROCEROS (Ehrenberg). Plate 10, fig. 24a.

Peridinium macroceros EHRENBERG, Verh. Ber. Akad. d. Wiss. (1840) 201.

Ceratium tripos var. *macroceros* CLAPARÉDE and LACHMANN, Mem. Inst. Nat. Genéve 6 (1859) 397, pl. 19, fig. 1; CLEVE, Kongl. Sv. Vet.-Akad. Handl. (3) 32 (1899) 21; (8) 32 (1900) 21.

Ceratium macroceros STEIN, Org. Infusionsthiere (1882) pl. 14, figs. 1–11; CLEVE, Kongl. Sv. Vet.-Akad. Handl. (8) 32 (1900) 19; (7) 35 (1902) 24; OSTENFELD and SCHMIDT, Vidensk. Medd. 52 (1901) 167; OKAMURA and NISHIKAWA, Annot. Zool. Japon. 5 (1904) 122, fig. 2; OKAMURA, Annot. Zool. Japon. 6 (1907) pl. 4, figs. 19, 20; LEBOUR, Dinoflagellates Northern Seas (1925) 155, pl. 35; PAULSEN, Microplancton d'Alboran (1930) 87, fig. 54; BÖHM, Arch. f. Protist. (1931) 364; Bull. B. P. Bishop Mus. 87 (1931) 38, fig. 35*a*; NIELSEN, Dana Exp. Rept. 4 (1934) 25, fig. 59.

Medium-sized, long-horned species. Epitheca shorter than hypotheca, with a long horn very gradually tapering to an open end. Hypotheca with an almost straight, oblique hind margin making an oblique angle with the two antapical horns open at their tips. Antapical horns first diverging obliquely and posteriorly, then taking a turn anteriorly and running more or less parallel with the apical horn. Antapical horns provided with spines at curved portions and open at ends. Theca traversed by numerous irregularly longitudinal ridges and with numerous pores. With yellow chromatophores.

Length of cell body, about 59 μ; width, 55 μ.

Common in Manila Bay.

CERATIUM TRICHOCEROS (Ehrenberg). Plate 10, fig. 25a.

Peridinium trichoceros EHRENBERG, Verh. Berliner Akad. Wiss. (1840).

Ceratium trichoceros KOFOID, Bull. Mus. Comp. Zool. (6) 1 (1907); NIELSEN, Dana Exp. Rept. 4 (1934) 27, fig. 68; BÖHM, Arch. f. Protist. (1931) 365; WANG and NIE, Cont. Biol. Lab. Sci. Soc. 8 (1932) 303, fig. 15.

Theca thin, smooth, without ridges or pores; girdle incomplete, only on right oral side; only a tiny remnant of girdle visible on left oral side. Epitheca shorter than hypotheca, with

a long apical horn of almost uniform diameter. Hypotheca with two long, slender, antapical horns making a very obtuse angle with cell body, both open at ends, with yellowish chromatophores.

Cell body about 37 μ long and 44 to 48 μ wide.

This species is easily differentiated from *C. macroceros* by being much smaller, by the more obtuse angle of the antapical horns with the body, and by the absence of ridges on the theca and spines at the curved portions of the antapical horns.

Very common in Manila Bay.

CERATIUM CONTRARIUM Gourret. Plate 11, fig. 26a.

> *Ceratium tripos* var. *contrarium* GOURRET, Ann. Mus. d'Hist. Nat. (8) 1 (1883) pl. 3, fig. 51.
>
> *Ceratium tripos* var. *macroceros* fo. *contraria* SCHRÖDER, Mitt. Zool. Stat. Neapel 14 (1901) 16.
>
> *Ceratium contrarium* PAVILLARD, Trav. Inst. Bot. Univ. Montpellier (1905) 53, pl. 2, fig. 1; Bull. Soc. Bot. 54 (1907) 229; BÖHM, Arch. f. Protist. (1931) 365; Bull. B. P. Bishop Mus. 87 (1931) 40; NIELSEN, Dana Exp. Rept. 4 (1934) 27, fig. 67.

Delicate looking form with epitheca shorter than hypotheca. Epitheca converging to about 90° to form a very long, prominent, open, apical horn about 260 μ long. Left side of hypotheca only slightly longer than right. Antapical horns curved and long, directed anteriorly. Left posterior horn making an angle of 125° with the body, right posterior horn making an angle of about 135° with the body. Only left ventral part of girdle distinctly visible.

Length of body, excluding apical horn, 44 μ; greatest diameter, 40 μ; antapical horns, about 120 μ long.

Often met with in Puerto Galera Bay, Mindoro, during April.

CERATIUM MOLLE Kofoid. Plate 11, fig. 27a.

> *Ceratium molle* KOFOID, Bull. Mus. Comp. Zool. (6) 1 (1907); OKAMURA, Rept. Imp. Bur. Fish 1 (1912) 16, pl. 2, figs. 22–24, pl. 3, fig. 40; NIELSEN, Dana Exp. Rept. 4 (1934) 28, fig. 71.

Epitheca as long as hypotheca, narrowing to an angle of 75° to form a narrow, slender, gradually tapering, anterior horn which is open. Hypotheca with two more or less curved open horns, right horn making an angle of 130° with its wall, left horn making an angle of 150° with its wall; both horns directed anterolaterally. Posterior border of antapical horns with prominent spinelets. Left side of hypotheca about twice right, giving its posterior border an oblique angle with axis of body.

Total length including apical horn, 144 μ; depth of body, 40 μ; right antapical horn 72 μ long, left, 48.

Common in Puerto Galera Bay, Mindoro, in April.

Family DINOPHYSIDÆ Kofoid and Michener

Body compressed laterally, divided by a seam into two lateral halves. Transverse furrow situated far apically, making epitheca obsolete and much smaller than hypotheca. Epitheca more or less enclosed by upper list which forms a cup. Transverse or cingular lists prominent, directed apically, supported by fine radiating ribs. Longitudinal or sulcal lists wide, supported by few ribs. Apical pore absent. Test usually poroid or with pores.

Genus PHALACROMA Stein (1883)

Small forms with bodies only slightly flattened, wedge-shaped, and egg-shaped in lateral view. Epitheca poorly developed, appearing as a flat lid above transverse girdle. Transverse lists with fine ribs not highly developed as in other genera. Left longitudinal list usually well developed with three spines. Chromatophores absent. Test strongly poroid.

PHALACROMA ROTUNDATUM Claparéde and Lachmann. Plate 12, fig. 28.

Phalacroma rotundatum CLAPARÉDE and LACHMANN, Mem. Inst. Nat. Genéve 5 (1858) pl. 20, fig. 13; 6 (1859) 409, pl. 20, fig. 16; STEIN, Org. Infusionsthiere (1883) pl. 19, figs. 9–11; pl. 20, figs. 1, 2; LEBOUR, Dinoflagellates Northern Seas (1925) 78, pl. 11, figs. 3*a*–3*c*; PAULSEN, Microplancton d'Alboran (1930) 32, fig. 17; BÖHM, Bull. B. P. Bishop Mus. 137 (1936) 15, fig. 5*a*.

Dinophysis rotundata MEUNIER, Duc D'Orleans Campagne Arctique 1 (1910) 59, pl. 3, figs. 43–46; Mem. Mus. Roy. d'Hist. Nat. pt. 4 8 (1919) 79, pl. 20, figs. 14–20; FAURÉ-FREMIET and PUIGAUDEAU, Bull. Soc. Zool. 48 (1923) 261, fig. 2; ABE, Sci. Rep. Tohoku Imp. Univ. 2 (1927) 385, fig. 2; KOFOID and SKOGSBERG, Mem. Mus. Comp. Zool. 51 (1928) 67; SCHILLER, Arch. f. Protist. 61 (1928) 66, 67; TAI and SKOGSBERG, Arch. f. Protist. 82 (1934) 426, fig. 2.

Cell oval, compressed, widest at middle. Epitheca small, hardly extending beyond rim of upper list. Hypotheca smooth, without protuberances. Left sulcal list relatively narrow, broadening slightly abapically. Theca finely poroid. Cell content pinkish, with yellowish fat globules.

Length 46 μ, width 40 μ.

At times found in Manila Bay.

PHALACROMA CUNEUS Schütt. Plate 12, fig. 29.

Phalacroma cuneus SCHÜTT, Ergeb. Plankton Exped. 4 (1895) 148, pl. 3, fig. 14; Natürliche Pflanzenfamilien 1 (1896) 27, fig. 38*b*; CLEVE, Kongl. Sv. Vet.-Akad. Handl. (5) 35 (1901) 16; CLEVE, Göteborgs Vetensk. Handl. IV 4 (1902) 35; Ark. f. Zool. 1 (1903) 347; SCHRÖDER, Mitt. Zool. Stat. Neapel 14 (1901) 19; OSTENFELD and SCHMIDT, Vidensk. Medd. 52 (1901) 175; KOFOID, Univ. Cal. Pub. Zool. (13) 3 (1907) 195; KARSTEN, Wiss. Ergeb. Deuts. Tief.-Exp. 2 (1907) 325, 353, 355; PAVILLARD, Bull. Soc. Bot. 56 (1909) 283; 70 (1923) 878; Prince Monaco Res. Campagnes Scientifiques 82 (1931) 41; OKAMURA, Rep. Imp. Bur. Fish 1 (1912) 18, pl. 5, fig. 76; DANGEARD, Ann. L'Inst. Oceanog. (1927) 380; KOFOID and SKOGSBERG, Mem. Mus. Comp. Zool. 51 (1928) 124–139, fig. 58*b*; SCHILLER, Arch. f. Protist. 61 (1928) 71; LINDEMANN, Nat. Pflanzenfamilien 2 (1928) 74.

Cell more or less wedge-shaped; epitheca low, broadly rounded; hypotheca with narrowly rounded posterior portion; greatest diameter at region of posterior cingular list, which is subhorizontal and as wide as the transverse furrow. Left sulcal list wide and prominent, right narrow and inconspicuous. Wall provided with a reticulum of small polygons, each with a tiny pore at the center. There are from 25 to 35 polygons bordering the posterior margin of the girdle, on each valve.

Length about 82 μ; greatest depth about 84 μ.

Occasionally met with in Puerto Galera Bay, Mindoro.

PHALACROMA MITRA Schütt. Plate 12, fig. 30.

Phalacroma mitra SCHÜTT, Nat. Pflanzenfamilien 1 (1896) 27, fig. 38; OKAMURA, Annot. Zool. Japon. 6 (1907) 134, pl. 5, fig. 43; Rep. Imp. Bur. Fish. 1 (1912) pl. 5, figs. 78–80; ABE, Sci. Rep. Tohoku Imp. Univ. 2 (1927) 385, fig. 3*a*; SCHILLER, Arch. f. Protist. 61 (1928) 72; KOFOID and SKOGSBERG, Mem. Mus. Comp. Zool. 51 (1928) 75; PAULSEN, Microplancton d'Alboran (1930) 23.

Phalacroma rapa LINDEMANN, Nat. Pflanzenfamilien 2 (1928) 74. fig. 58; MATZENAUER, Bot. Archiv 35 (1933) 443.

Body wedge-shaped, more or less oblong anteriorly and becoming compressed posteriorly. Lateral view more or less oval, widest at middle. Epitheca symmetrical, low, only slightly projecting above upper list. Lists of girdle prominent, supported by fine ribs. Left longitudinal list supported by three spines. Test coarsely areolated.

Length and greatest width about 56 μ.

Rarely met with in Manila Bay (seen only once in June, 1936).

PHALACROMA DORYPHORUM Stein. Plate 12, fig. 31.

Phalacroma doryphorum STEIN, Org. Infusionsthiere (1883) pl. 19, figs. 1–4; SCHRÖDER, Mitt. Zool. Stat. Neapel 14 (1901) 19; CLEVE, Ark. f. Zool. 1 (1903) 347; PAVILLARD, Bull. Soc. Bot. 56 (1909) 283; Resultats des Campagnes Scientifiques 82 (1931) 42; OKAMURA, Rep. Imp. Bur. Fish 1 (1912) 18, pl. 5, fig. 77; KOFOID and SKOGSBERG, Mem. Mus. Comp. Zool. 51 (1928) 175, fig. 23.

Dinophysis galea POUCHET, J. Annot. Physiol. (1883) 426, fig. *G*; DANGEARD, Ann. L'Inst. Oceanog. (1927) 380.

Cell more or less subovate in lateral outline. Epitheca moderately convex to rather flat, hardly extending beyond edge of anterior cingular list. Hypotheca symmeterical, more or less oval with strongly convex posterior margin. Transverse furrow flat or slightly convex. Cingular lists structureless, unequal, both directed apically; left sulcal list with three well-defined ribs and with cingular posterior margin; cell with a triangular sail. Thecal wall finely areolate, with widely scattered pores.

Length about 68 μ; greatest depth about 64 μ.

Occasionally met with in Puerto Galera Bay, Mindoro.

Genus DINOPHYSIS Ehrenberg (1839)

Body much flattened, egg-shaped, elongate, or forked in lateral view. Epitheca much reduced, usually completely enclosed by upper cingular list which is funnel-shaped. Upper cingular list more developed than lower, both directed upward, supported by fine ribs. Hypotheca making up almost all of body. Posterior tip provided with one or two knobs or spines.

Left sulcal list as in *Phalacroma.*

DINOPHYSIS MILES fo. INDICA Cleve. Plate 12, fig. 32.

Dinophysis miles fo. *indica* CLEVE, Öfv. Kongl. Sv. Vet.-Akad. Förhandl. (9) 57 (1900) 1030–1031; KARSTEN, Wiss. Ergeb. Deuts. Tief.-Exp. 2 (1907) 419, pl. 47; MATZENAUER, Bot. Arch. 35 (1933) 446, 503, fig. 10; BÖHM, Bull. B. P. Bishop Mus. 137 (1936) 26.

Dinophysis aggregata WEBER and VAN BOSSE, Ann. Jard. Bot. Buit. 2 (1901) 140, pl. 17, fig. 344.

Cell more or less fork-shaped posteriorly. Epitheca obsolete, upper list more or less cup-shaped, supported by ribs. Longitudinal list ribbon-shaped, supported by three prominent ribs. Dorsal process of hypotheca shorter than ventral, only very slightly curved ventrally at posterior portion and with a tiny knob at tip. Ventral process almost straight, with two tiny knobs at tip.

Length about 148 μ, greatest width about 44 μ.

Common in Manila Bay (June).

DINOPHYSIS CAUDATA Kent, 1882. Plate 12, figs. 33a and 33b.

Dinophysis caudata KENT, Manual Infusoria (1881); PAVILLARD, Bull Soc. Bot. 56 (1909) 881; LEBOUR, Dinoflagellates Northern Seas (1925) 82, text fig. 21*c*; SCHILLER, Arch. f. Protist. 61 (1928) 78; KOFOID and SKOGSBERG, Mem. Mus. Comp. Zool. 51 (1928) 314, figs. 44, 46; PAULSEN, Microplancton d'Alboran (1930) 34, fig. 19; WANG and NIE, Cont. Biol. Lab. Sci. Soc. (9) 8 (1932) 309, fig. 21; MATZENAUER, Bot. Archiv 35 (1933) 445; CAMPBELL, Journ. Ent. Zool. 26 (1934) 18, fig. 3; TAI and SKOGSBERG, Arch. f. Protist. 82 (1934) 453, text figs. 9, 10*D*, 10*E*.

Dinophysis humunculus STEIN, Org. Infusionsthiere (1883) 24, pl. 21, figs. 1, 2, 5, 7.

Cell much flattened, epitheca rudimentary, hidden by deep, funnellike, upper, transverse list. Hypotheca long, with an elongate, fingerlike, antapical lobe provided with two spinelets at tip. Upper girdle list prominent, funnel-shaped, supported by strong radial ribs. A small dorsal finlet present. Theca very prominently areolated. Cell with yellow chromatophores. It appears that this species is represented in Manila by both the pedunculate and the abbreviate varieties.

Length, 80 μ to 100 μ; width, 45 μ to 49 μ (excluding longitudinal list).

Common in Manila Bay.

DINOPHYSIS HASTATA Stein. Plate 12, fig. 34.

Dinophysis hastata STEIN, Org. Infusionsthiere (1883) pl. 19, fig. 12; MURRAY and WHITTING, Trans. Linn. Soc. II 5 (1899) 331, pls. 1–3, 6; OSTENFELD and SCHMIDT, Vidensk. Medd. 52 (1901) 169; CLEVE, Göteborgs Vet. Handl. IV 4 (1902) 29; Arch. f. Zool. 1 (1903) 343; KARSTEN, Ergeb. Deuts. Tief.-Exped. 2 (1907) 234; PAVILLARD, Bull. Soc. Bot. 56 (1909) 283, 284; 70 (1923) 879, 880, fig. 2*a*; OKAMURA, Rep. Imp. Bur. Fish 1 (1912) 19, 32, figs. 73–75; KOFOID and SKOGSBERG, Mem. Mus. Comp. Zool. 51 (1928) 261–272, fig. 32.

Phalacroma hastatum PAVILLARD, Bull. Soc. Bot. 56 (1909) 283, fig. 4; 70 (1923) 879, 880; LEBOUR, Dinoflagellates Northern Seas (1925) 83, fig. 21*e*.

Dinophysis hastata var. *parvula* LINDEMANN, Bot. Arch. 5 (1923) 219, fig. 6.

Cell inside more or less oblong. Epitheca insignificant, hardly protruding beyond base of anterior cingular list. Transverse groove convex. Anterior cingular list prominently ribbed and seemingly larger than posterior. Posterior cingular list structureless, at base of which is a transverse row of prominent pores. Hypotheca more or less ovoid. Left sulcal list prominent, wider and pointed posteriorly, with three large ribs, posterior rib

longest and rugged. Cell with triangular sail with two large median and several small marginal ribs. Theca areolate or with pores.

Length, about 72 μ; width, 60 μ.

Sometimes met with in Puerto Galera Bay, Mindoro.

Family TINTINNIDINÆ Kofoid Campbell

Lorica usually tubular or saccular; with or without suboral spiral structure, but rarely with collar or suboral differentiation; aboral end sometimes enlarged, never with fins, either open or closed; wall with primary alveoli only, soft, with agglomerating materials, without highly developed, well-separated lamellæ in lorica.

Genus TINTINNIDIUM Kent (1882)

Tintinnididæ with generally elongate lorica with aboral end closed or with a minute opening; collar sometimes present; wall viscous with agglomerating foreign bodies.

TINTINNIDIUM PRIMITIVUM Busch. Plate 13, figs. 35a to 35c.

Tintinnidium primitivum BUSCH, Verh. Deuts. Zool. Ges. 28 (1923) 71; Arch. f. Protist. 54 (1925) 183–190, figs. *a–d;* CAMPBELL, Journ. Ent. Zool. 26 (1926) 124; KOFOID and CAMPBELL, Univ. Cal. Pub. Zool. 34 (1929) 15, fig. 3.

Lorica tubular, straight, of nearly uniform diameter, without collar. Oral end about 4.8 to entire length. Oral opening occupying entire oral width. Aboral end with a slightly smaller diameter and with only a tiny opening situated at one side of flattened aboral surface. Wall not of uniform thickness, with few agglomerating foreign bodies.

Total length, about 160 μ; oral diameter, about 33.3 μ; basal diameter, 29.6 μ.

TINTINNIDIUM CYLINDRICA sp. nov. Plate 13, fig. 36.

Lorica tubelike, with a wall of medium thickness and a distinct hyaline, structureless collar. Shoulder of bowl at right angles to collar. Height of collar about 16 times in total length. Cavity of uniform diameter, equal to diameter of collar which is about 19 μ. Aboral end rounded, usually with an irregular break (resulting perhaps from detachment). Wall coarsely granular with few coarse agglomerations.

Total length, 126 μ; greatest diameter, 33 μ; thickest portion of wall, 8 μ.

Type locality.—Bacoor Bay, Philippines.

This species differs from *T. ampullarium* in being slenderer, in having a thinner wall, and in having the shoulder of the bowl at right angles to the collar instead of sloping.

TINTINNIDIUM AMPULLARIUM sp. nov. Plate 13, figs. 37a and 37b.

Lorica flask-shaped, with a thick, finely granular wall and a distinct, hyaline, structureless collar. Shoulder next to collar sloping. Height of collar 10 times in total length. Cavity of uniform diameter, equal to oral diameter. Aboral end somewhat flattened, always with irregular opening (perhaps a break resulting from detachment).

Oral diameter, 17 μ; total length, about 100 μ; greatest diameter, 45 μ, which is about twice diameter of aboral region; thickest portion of wall about 14 μ.

Type locality.—Manila Bay, Philippines.

Genus LEPROTINTINNUS Jörgensen (1899)

Tintinnididæ with tubelike, elongate lorica open at both ends; collar absent; surface sticky with agglomerating foreign bodies; wall soft and coarsely alveolar.

LEPROTINTINNUS NORDQUISTI (Brandt). Plate 13, figs. 38a to 38c.

Tintinnopsis nordquisti BRANDT, Ergeb. Plankton Exp. 3 (1906) 18, pl. 24, figs. 1–4; 3 (1907) 166, 167, 444, 473; OKAMURA, Annot. Zool. Japon. 6 (1907) 138, pl. 6, fig. 61.

Leprotintinnus nordquisti KOFOID and CAMPBELL, Univ. Cal. Pub. Zool. 34 (1929) 17, fig. 13; WANG and NIE, Cont. Biol. Lab. Sci. Soc. 8 (1932) 341. fig. 49.

Lorica long, tubular; basal portion well expanded, about 2.6 wider than rest of tube; wall with fine agglomerating particles.

Most of Philippine specimens examined have total length, 118 μ; oral diameter, 40 μ; diameter of basal portion of tube, 29 μ; diameter of expanded base, about 78 μ. Some variations occur, however. The individual shown in Plate 13, fig. 38*b*, is very long and slightly narrower, while the individual shown in Plate 13, fig. 38*c*, is much shorter, slightly thicker, and with a narrower expanded base.

Very common in Manila Bay, Philippines.

LEPROTINTINNUS TUBULOSUS sp. nov. Plate 13, fig. 39.

Lorica long, in form of a simple tube, basal portion not at all expanded; oral diameter about 3.9 in total length; wall thin.

with fine agglomerating particles. Lorica about 140 μ long and 37 μ in diameter. Specimens showing transverse budding are often met with.

Type locality.—Manila Bay, Philippines.

Family CODONELLIDÆ Kent

Bowl globose, conical or cylindrical; oral end without hyaline structure or collar. Aboral end generally closed, rounded or pointed, with or without horn; wall with fine primary alveoli and coarse secondary structures, which are irregular in arrangement and size and not differentiated into inner and outer lamina.

Genus TINTINNOPSIS Stein (1867)

Codonellidæ with lorica usually bowl-shaped, never with a narrow oral opening; aboral end usually closed, but very rarely with an irregular (broken ?) aperture; wall thin, with a fine primary structure and freely agglomerated matter and detritus.

TINTINNOPSIS BACOORENSIS sp. nov. Plate 14, fig. 40.

Lorica campanulate, with an expanded bulbous fundus and a spreading oral rim. Between fundus and flaring collar a cylindrical middle portion, the neck. Oral rim rugged, about 1 in total length; diameter of neck about 1.75 in total length; bulbous portion about 1.38 in total length. Wall with thick agglomerations of various sizes.

Total length, 63.8 μ; oral rim diameter, 63.8 μ, neck, 29.6 μ; fundus, 41.9 μ.

This species differs from *T. mortensenii* in having a bulbous fundus distinctly set off from the central cylindrical portion which has a smaller diameter. In the figure of Kofoid and Campbell as well as in that of Okamura such a differentiated neck is not visible.

Type locality.—Manila Bay, Philippines.

TINTINNOPSIS BÜTSCHLII Daday. Plate 14, fig. 41.

Tintinnopsis bütschlii DADAY, Mitt. Zool. Stat. Neapel 7 (1887) 556, pl. 20, figs. 4, 5; KOFOID and CAMPBELL, Univ. Cal. Pub. Zool. 34 (1929) 29, fig. 85; HADA, Sci. Rep. Tohoku Imp. Univ. (4) 7 (1932) 557, 558, text fig. 5.

Codonella bütschlii AURIVILLUS, Kongl. Sv. Vet.-Akad. Handl. (3) 30 (1898) 111.

Tintinnopsis campanula var. *bütschlii* BRANDT in part, Ergeb. Plankton-Exp. 3 (1907) 151–152, 456; JÖRGENSEN, Rep. Danish Ocean. Exp. Biol. 2 (1924) 67, 69, fig. 76*a;* Tierwelt Nord. Ostsee pt. 2 8 (1927) 6, 7, fig. 2; ENTZ, Arch. f. Protist. 15 (1909) 106, pl. 20, fig. 46, 47, 49; PAULSEN, Microplancton d'Alboran 4 (1930) 96.

Lorica bell-shaped, composed of an everted, expanded oral region and a convex rounded bowl; oral rim irregular, diameter about 1.05 in length; bowl narrowest about upper third, transdiameter about 2.1 in total length. Oral diameter, above 67 μ; smallest transdiameter, about 34; total length, about 71.

Rarely met with in Bacoor Bay (a part of Manila Bay), Philippines.

TINTINNOPSIS GRACILIS Kofoid and Campbell. Plate 14, fig. 42.

Tintinnopsis karajacensis var. *a* BRANDT, Ergeb. Plankton-Exp. 3 (1906) 16, pl. 19, figs. 1, 2, 21; (1907) 163, 488; HADA, Sci. Rep. Tohoku Imp. Univ. (4) 7 (1932) 558, text fig. 6.

Tintinnopsis gracilis KOFOID and CAMPBELL, Univ. Cal. Pub. Zool. 34 (1929) 36, fig. 37; WANG and NIE, Cont. Biol. Lab. Sci. Soc. China (9) 8 (1932) 343, fig. 50.

Lorica tubular, oral diameter 3.4 in total length; oral rim regular; aboral half slightly swollen with a slightly greater diameter than oral half. Aboral region conical but without a definite point. Wall thick, with heavier coarse agglomerations on the aboral half.

Length, about 112 μ; oral diameter, 33 μ.

Unlike the figure of Kofoid and Campbell, these specimens show a distinct constriction between the oral and aboral halves. In some specimens the aboral end is seemingly open.

Quite common in Manila Bay.

TINTINNOPSIS LORICATA (Brandt). Plate 14, fig. 43.

Tintinnopsis dadayi var. *b loricata* BRANDT, Ergeb. Plankton-Exp. 3 (1906) 16, 17, pl. 19, fig. 4, pl. 20, fig. 11; (1907) 130, 144–146, 470.

Tintinnopsis loricata KOFOID and CAMPBELL, Univ. Cal. Pub. Zool. 34 (1929) 39, fig. 60; WANG and NIE, Cont. Biol. Lab. Sci. Soc. China (1932) 345, fig. 53.

Lorica an elongate bell; oral rim ragged, with diameter 1.7 in total length; suboral region in the form of a flaring collar, 5.1 in total length; test or lorica cylindrical, diameter 2.16 in total length; aboral region convex-conical, ending bluntly; agglomeration coarse, with distinct primary alveoli.

Length 152 μ.

Rarely met with in Manila Bay.

TINTINNOPSIS MANILENSIS sp. nov. Plate 14, fig. 44.

Lorica tall, campanulate, with an irregular oral opening about 1.2 in total length, and a convex, rounded, expanded fundus. Bowl narrowest at its middle, which is visibly in the form of a neck; oral margin of lorica in the form of a flaring collar, di-

verging to about 45°; neck diameter 3, neck length also 3 in total length; bulbous portion with a diameter 2.2 in total length; wall with thick agglomerations of various sizes and shapes.

Oral diameter, about 67 μ; smallest transdiameter of neck, 26 μ; diameter of fundus, 37 μ; total length, 81.5 μ.

This species is closely allied to *T. bütschlii*. It differs from the latter, however, in having a distinct narrowed portion of the bowl, here called the neck, which is visibly set off from the bulbous terminal fundus. It is almost twice as long as *T. bacoorensis*.

Type locality.—Manila Bay.

TINTINNOPSIS MAJOR Meunier. Plate 15, fig. 48.

> *Tintinnopsis major* MEUNIER, Duc D'Orleans Campagne Arctique 1 (1910) 138, pl. 12, fig. 1; KOFOID and CAMPBELL, Univ. Cal. Pub. Zool. 34 (1929) 39, fig. 18.

Lorica small, more or less cup-shaped; oral diameter about the same as length; bowl with straight sides at oral half; aboral half more or less rounded (50°, then 110°); wall with coarse, angular agglomerations of varied sizes.

Length, about 52 μ.

Common in Manila Bay.

T. major was first reported from much colder waters off Tromsö, Norway.

TINTINNOPSIS MORTENSENII Schmidt. Plate 15, fig. 49.

> *Tintinnopsis mortensenii* SCHMIDT, Vidensk. Medd. 52 (1901) 186, fig. 3.
>
> *Tintinnopsis mortenseni* BRANDT, Ergeb. Plankton-Exp. 3 (1906) 17, 18, pl. 21, figs. 13, 13*a*; (1907) 152, 444, 472; OKAMURA, Annot. Zool. Japon. 6 (1907) 138, pl. 6, fig. 65.

Lorica campanulate, with a rounded fundus, not distinctly set off from the more or less straight side, and a wide, everted oral rim. Diameter of bowl about 1.6 in entire length of lorica which in turn is 1.4 in oral rim diameter.

Total length, 63 μ; diameter of bowl, 36 μ; diameter of oral rim, 83 μ.

Met with in Bacoor Bay during January.

This species differs from *T. bacoorensis* in having a wider, more flaring oral rim and in not having a distinct separation between the fundus and the cylindrical portion of the lorica.

TINTINNOPSIS RADIX (Imhof). Plate 14, fig. 45.

Codonella radix IMHOF, Zool. Anz. 9 (1886) 103; KOFOID and CAMPBELL, Univ. Cal. Pub. Zool. 34 (1929) 45, fig. 93; PAULSEN, Microplancton d'Alboran (1930) 96.

Tintinnopsis davidoffii DADAY, Mitt. Zool. Stat. Neapel 7 (1887) 552, pl. 19, fig. 23.

Tintinnopsis curvicauda DADAY, Mitt. Zool. Stat. Neapel 7 (1887) 554, 555, pl. 19, fig. 33.

Tintinnopsis radix BRANDT, Ergeb. Plankton-Exp. 3 (1907) 20, 465, 477; HADA, Sci. Rep. Tohoku Imp. Univ. (4) 7 (1932) 560, 561, text fig. 10.

Tintinnopsis fracta OKAMURA, Annot. Zool. Japon. 6 (1907) 137, pl. 6, fig. 57; BRANDT, Ergeb. Plankton-Exp. 3 (1906) pl. 23, figs. 1, 3–5, 9–13, pl. 31, fig. 8; (1907) 174.

Lorica an elongate cone, gradually tapering from a wide oral end to an irregularly pointed aboral tip. Oral rim irregular, about 5.6 entire length. Agglomerations fine.

Total length about 247 μ.

Very common in Manila Bay.

TINTINNOPSIS TOCANTINENSIS Kofoid and Campbell. Plate 14, fig. 46.

Tintinnopsis aferta var. *a* BRANDT, Ergeb. Plankton-Exp. 3 (1906) 19, pl. 25, figs. 2, 7; (1907) 129, 177.

Tintinnopsis tocantinensis KOFOID and CAMPBELL, Univ. Cal. Pub. Zool. 34 (1929) 48, fig. 46; HADA, Sci. Rep. Tohoku Imp. Univ. (4) 7 (1932) 559, fig. 8; WANG and NIE, Cont. Biol. Lab. Sci. Soc. China (9)/8 (1932) 343, fig. 51.

Lorica elongate, anterior cylindrical portion about 2 in total length, transdiameter about 5 in total length; aboral fourth of lorica bulbous, diameter about 3.6 in total length; dilated portion tapering abruptly into a stout aboral horn, 5 in total length.

Oral diameter, 18.5 μ; total length, 93 to 110 μ; diameter of bulbous portion, about 34 μ.

Very common in Manila Bay.

TINTINNOPSIS TURGIDA Kofoid and Campbell. Plate 14, fig. 47.

Tintinnopsis karajacensis var. *d* BRANDT, Ergeb. Plankton-Exp. 3 (1906) 17, 19, pl. 19, figs. 9, 20, pl. 26, fig. 9; (1907) 163, 469; HADA, Sci. Rep. Tohoku Imp. Univ. (4) 7 (1932) 558, text fig. 6.

Tintinnopsis turgida KOFOID and CAMPBELL, Univ. Cal. Pub. Zool. 34 (1929) 49, fig. 65.

Lorica cylindrical orally, expanding aborally to a bulbous portion 1.3 times diameter of long neck. Neck about 1.7, bul-

bous portion about 2.55 in total length. Oral region slightly everted to about diameter of bulbous portion. In some specimens this oral eversion is not present. Wall with irregular particles of various shapes and sizes.

Total length, 85 μ.

Very common in Manila Bay.

Family CODONELLOPSIDÆ Kofoid and Campbell

Lorica more or less top-shaped, oral rim entire; hyaline collar with annular or spiral structure and with bowl which is short, ovate, with closed rounded or pointed, aboral horn, and with coarse secondary structure.

Genus CODONELLOPSIS Jörgensen (1924)

Codonellopsidæ with lorica divided into an annular collar and a bowl; collar hyaline, distinctly set off from bowl, and with spiral structure or with one or two sometimes obscure bands; bowl oval to spheroidal, wall with primary, secondary, and tertiary structure; agglomerating material often on wall.

CODONELLOPSIS OSTENFELDI (Schmidt). Plate 15, fig. 50.

Codonella ostenfeldi SCHMIDT. Vidensk. Medd. **52** (1901) 187, fig. 4; BRANDT, Ergeb. Plankton-Exp. **3** (1906) 15, 17; pl. 14, figs. 1, 2; pl. 15, fig. 2; pl. 20, fig. 10; (1907) 122–124; OKAMURA, Annot. Zool. Japon. **6** (1907) 137, pl. 6, figs. 53*a*, 53*b*; KOFOID and CAMPBELL, Univ. Cal. Pub. Zool. **34** (1929) 84, fig. 160.

Codonella fenestrata CLEVE, Kongl. Sv. Vet.-Akad. Handl. (5) **35** (1901) 53, pl. 7, fig. 15.

Codonella morchella var. *ostenfeldi* SCHMIDT, Vidensk. Medd. **52** (1901) 187; CLEVE, Ark. f. Zool. **1** (1903) 350; OKAMURA. Annot. Zool. Japon. **6** (1907) 137, pl. 6, fig. 54.

Tintinnopsis ostenfeldi BRANDT, Ergeb. Plankton-Exp. **3** (1907) 123, 125.

Codonellopsis ostenfeldi WANG and NIE, Cont. Biol. Lab. Sci. Soc. China (9) **8** (1932) 348, fig. 57.

Lorica with bowl and collar; collar nearly cylindrical, with little or no oral eversion, its diameter 1.7 in its length; mostly with 7 rows of prominent, closely set apertures, bowl spherical, slightly longer than wide; shoulder moderately emergent, aboral end rounded; agglomerated particles coarse.

Length, about 100 to 120 μ.

Rather common in Manila Bay.

Family COXLIELLIDÆ Kofoid and Campbell

Lorica open or closed at aboral end, if closed often irregular; collar present or absent; with coiled lamina forming lorica fully or partially; wall without agglomerated particles.

Genus COXLIELLA Brandt (1907)

Lorica usually tall, bowl- or vaselike; oral rim never denticulate, without differentiated collar; wall double, usually with two laminæ, with coarse, secondary structure; lorica formed by a single spiral band with superimposed turns of varying heights to a greater or less extent.

COXLIELLA LONGA (Brandt). Plate 15, fig. 51.

Cyttarocylis (?) *ampla* (?) var. *c longa* BRANDT, Ergeb. Plankton-Exp. 3 (1906) 20, pl. 28, fig. 3; (1907) 272, 453, 470.

Cyttarocylis (?) *laciniosa* var. *longa* BRANDT, Ergeb. Plankton-Exp. 3 (1907) 31, 262, 272, 453, 469, 470.

Coxliella laciniosa var. *longa* LAACKMANN, Deuts. Südp. Exp. 11 (1909) 456.

Coxliella longa KOFOID and CAMPBELL, Univ. Cal. Pub. Zool. 34 (1929) 101, fig. 196.

Lorica bullet-shaped, oral diameter about 2 in total length; oral rim irregularly and finely denticulate; bowl cylindrical for 0.6 of total length; wall with 13 turns.

Length about 205 μ; oral diameter, 102 μ.

Occasionally met with in Manila Bay (August 3, 1936). Differs from a species described by Kofoid and Campbell in not having a "short, stout, curved point" at aboral end.

Family CYTTAROCYLIDÆ Kofoid and Campbell

Lorica usually large, bell-shaped, often stalked. Oral rim variable, with or without a collar; aboral end closed, without spiral structure. Wall with primary and very regular secondary and sometimes tertiary structure, with prominent prismatic structure between the two lamellæ of the lorica.

This family is usually divided into 2 subfamilies: Cyttarocylineæ in which a flaring collar is usually present and a distinct aboral horn is absent; and Favellineæ in which a flaring collar is absent, but an aboral horn often present.

Genus FAVELLA Jörgensen (1924)

Favellineæ with lorica usually campanulate or subconical; oral rim entire, or with small skirt, or with denticles, no collar distinct from bowl, but sometimes one or more rings; aboral horn usually present, thick-walled; wall with two lamellæ, usually with coarse, intermediate prismatic secondary alveoli and a very fine, primary structure, never with regular polygonal structure.

FAVELLA SIMPLEX sp. nov. Plate 15, fig. 52.

Lorica campanulate, widest at oral region, its total length about 2.17 oral diameter, oral rim smooth; oral region with al-

most straight sides and bowl almost cylindrical to about 0.46 of its length; aboral region with slightly convex sides and contracting to about 55°; aboral horn about 0.32 oral diameter, with a slight constriction at middle, tip pointed. Wall double, thin and structureless. Oral diameter, 70 μ; total length, 152 μ; aboral horn, 25 μ.

Type locality.—Manila Bay.

FAVELLA PHILIPPINENSIS sp. nov. Plate 15, fig. 53.

Lorica cylindrical, stout, its length about 1.7 oral diameters; oral rim slightly serrate or denticulate, with two narrow rings; orally bowl cylindrical for about 0.70 of its length, with a slight nuchal constriction; aboral region more or less conical, contracting to about 70°; aboral horn about 0.43 oral diameter in length, and a pointed cone (20°), tip pointed; wall very smooth and finely alveolar.

Oral diameter, 108 μ; length excluding horn, 215 μ; aboral horn, 47 μ.

Similar to *F. panamensis* Kofoid and Campbell in many respects, except in the fine serration of the oral rim. A number of specimens were seen in which the lorica is slightly wider (oral diameter about 1.5 in the length).

Type locality.—Manila Bay.

FAVELLA ELONGATA sp. nov. Plate 15, fig. 54.

Lorica cylindrical, long, its length about 2.6 oral diameters; oral rim irregularly serrate with two very narrow rings without a definite nuchal constriction; anteriorly bowl cylindrical for about 70 per cent of its length; aboral region more or less rounded, contracting gradually to about 80 per cent; aboral horn proportionally small for the size of the bowl, 0.38 oral diameter, with rounded tip. Wall alveolar, double, with striæ between.

Oral diameter, 115 μ; length of bowl, about 299 μ; aboral horn, 43 μ.

This species is much longer than *F. philippinensis*, and the aboral region is more rounded.

Type locality.—Manila Bay.

FAVELLA AZORICA (Cleve). Plate 15, fig. 55.

Undella azorica CLEVE, Öfv. Kongl. Sv. Vet.-Akad. Forhandl. 57 (1900) 974, fig. 10; BRANDT, Ergeb. Plankton-Exp. 3 (1907) 212, 377, 405, 409, 455.

Favella azorica JÖRGENSEN, Rep. Danish Oceanog. Exp. Biol. 2 (1924) 6–8, 24–27, 37, 72, 105, fig. 28; KOFOID and CAMPBELL, Univ. Cal. Pub. Zool. 34 (1929) 151, fig. 284; MARSHALL, Great Barrier Reef Exp. (15) 4 (1934) 642, text fig. 15.

Lorica campanulate, oral diameter about 1.4 in length; oral region with one annulus; bowl almost cylindrical for over one-half orally, then converging to about 75° to form a blunt, somewhat rounded, thick-looking abapical end; wall finely reticulate, with two distinct lamellæ.

Length, about 104 μ; oral diameter about 70 μ.

Specimens examined agree closely with Marshall's figure of a specimen obtained from the Great Barrier Reef, except for having only one annulus.

Occasionally met with in Puerto Galera Bay, Mindoro.

Family PTYCHOCYLIDÆ Kofoid and Campbell

Lorica stout, kettle- or acorn-shaped; with or without suboral ledge or thickened region; aboral portion sculptured externally; wall with two lamellæ, with a distinct reticulum except at the suboral region.

Genus EPIPLOCYLIS Jörgensen (1924)

Ptychocylidæ with acornlike lorica; with a reticulated zone on the posterior portion which sometimes extends toward the collar, but never to the oral rim; wall thick, with large, heavy, and developed reticulation.

EPIPLOCYLIS EXQUISITA (Brandt). Plate 16, fig. 56.

Ptychocylis exquisita var. *e* BRANDT, Ergeb. Plankton-Exp. **3** (1906) 29, pl. 61, figs. 1, 1*a;* (1907) 295–296, 482.

Ptychocylis exquisita var. *f* BRANDT, Ergeb. Plankton-Exp. **3** (1906) 29, pl. 61, fig. 4; (1907) 296, 482.

Epiplocylis exquisita KOFOID and CAMPBELL, Univ. Cal. Pub. Zool. **34** (1929) 179, fig. 342.

Lorica acornlike, wide in diameter in proportion to length; oral rim smooth, with a diameter about 1.3 in total length; aboral region with a large, prominent horn about 4 in total length; fundus about 90°; wall of oral region coarsely granular; reticulations coarse, mostly on aboral half, only few lines reaching oral rim.

Length about 92 μ; oral diameter about 77 μ.

Obtained from Puerto Galera Bay, Mindoro.

EPIPLOCYLIS RALUMENSIS (Brandt). Plate 16, fig. 57.

Ptychocylis reticulata var. *ralumensis* BRANDT, Ergeb. Plankton-Exp. **3** (1906) 28, 29, pl. 63, figs. 3, 8; (1907) 289.

Epiplocylis ralumensis KOFOID and CAMPBELL, Univ. Cal. Pub. Zool. **34** (1929) 184, fig. 320; MARSHALL, Great Barrier Reef Exp. (15) **4** (1934) 642.

Lorica moderately stout, oral diameter about 1.7 in total length; collar present, erect and entire; a suboral ledge present between oral rim and collar; bowl bulging; fundus about 102°; aboral horn about 30°, subconical, pointed, about 5.7 in total length; bowl uniformly and heavily reticulated throughout.

Total length, about 76 μ; oral diameter, 52 μ; aboral horn, 16 μ.

Obtained from Puerto Galera Bay, Mindoro.

EPIPLOCYLIS UNDELLA (Ostenfeld and Schmidt). Plate 16, fig. 58.

Cyttacocylis undella OSTENFELD and SCHMIDT, Vidensk. Medd. 52 (1901) 181, fig. 30.

Ptychocylis undella BRANDT, Ergeb. Plankton-Exp. 3 (1906) 29, pl. 59, figs. 1–5, pl. 60, figs. 1–6, pl. 61 (1907) 288; OKAMURA, Annot. Zool. Japon. 6 (1907) 138, pl. 6, fig. 51; Rep. Imp. Bur. Fish 1 (1912) 24, pl. 5, fig. 97.

Epiplocylis undella KOFOID and CAMPBELL, Univ. Cal. Pub. Zool. 34 (1929) 185, fig. 345; MARSHALL, Great Barrier Reef Exp. (15) 4 (1934) 645, fig. 18.

Lorica kettle-shaped, with a prominent aboral horn; oral rim smooth, with a diameter about 1.7 in total length; aboral horn about 4.5 in total length; reticulations coarse, confined on aboral half of bowl; oral half with very fine granulation, two laminæ of wall well separate.

Length, about 108 μ; oral diameter, about 64 μ; aboral horn, 24 μ.

Obtained from Puerto Galera Bay, Mindoro.

Family PETALOTRICHIDÆ Kofoid and Campbell

Lorica cup-shaped; oral rim smooth, wavy or denticulate; mouth usually wide, with one or two collars; wall hyaline or with primary prismatic structure.

Genus METACYLIS Jörgensen (1924)

Lorica short and wide, oval or elongate; mouth wide, with a low collar with few closely-set annuli; bowl wide, aboral end rounded, flattened, pointed or with a spinule; wall with or without distinct structure or hyaline.

METACYLIS HEMISPHÆRICA sp. nov. Plate 16, fig. 59.

A small species with stout basketlike lorica, oral diameter about 1.09 in total length; collar with height about 4.3 in total length, slightly contracting with four spiral laminæ; bowl rounded abapically; wall hyaline.

Length, about 45 μ; oral diameter, about 41 μ; greatest diameter of bowl, about 48 μ.

Differs from *A. corbula* Kofoid and Campbell in being shorter but wider and in having a much rounded bowl abapically.

Obtained from Puerto Galera Bay, Mindoro, Philippines.

METACYLIS KOFOIDI sp. nov. Plate 16, fig. 60.

Lorica stout, basketlike; oral diameter 1.2 in length; collar very low, about 6 in length, wall slightly contracting and with three spiral laminæ; bowl rounded, but with a slight knoblike protuberance abapically; wall hyaline.

Length, about 45 μ; oral diameter, about 37 μ; greatest diameter of bowl, about 45 μ.

Differs from *M. hemisphærica* in having a lower collar with only three laminæ, in being narrower, and in having a knob of the bowl abapically.

Type locality.—Puerto Galera Bay, Mindoro.

Named after Prof. Charles A. Kofoid, Protozoologist, University of California.

Genus PETALOTRICHA Kent (1882)

Lorica bowl-shaped or conical; oral shelf spreading; oral ridge low, collar conical, flaring; nuchal constriction slight or deep; bowl saclike or conical; one row of suboral fenestræ with horizontal axis; subnuchal fenestra circular or elliptical, with oblique or vertical axis.

PETALOTRICHA MAJOR Jörgensen. Plate 16, fig. 61.

Petalotricha ampulla var. *major* JÖRGENSEN, Rep. Danish Oceanog. Exp. Biol. 2 (1924) 89, figs. 100*a*, 100*b*.

Petalotricha major KOFOID and CAMPBELL, Univ. Cal. Pub. Zool. 34 (1929) 204, fig. 384.

Lorica pot-shaped, oral diameter 0.85 in length; oral shelf slightly cupped, rim wavy; collar (about 60°) with straight sides; bowl almost rounded, about as high as it is wide; wall with few scattered fenestræ above equator of bowl; a single line of small fenestræ below oral rim.

Length, about 92 μ; oral diameter, 108 μ.

Obtained from Puerto Galera Bay, Mindoro.

Family RHABDONELLIDÆ Kofoid and Campbell

Lorica chalice-shaped to conical; oral aperture smooth, without teeth; a gutter present about mouth between two wall laminæ; aboral end closed or with only a minute pore; longitudinal ribs present, simple, branched or anastomosing, reaching from pedicel to mouth; wall often with fenestræ between ribs.

Genus RHABDONELLA Kent (1907)

Lorica usually elongate, chalice-shaped, oral rim without teeth, but with a gutter between inner and outer laminæ; pedicel more or less protracted without apophyses; ribs prominent, may be branched; usually vertical or slightly twisted, with fenestræ between them.

RHABDONELLA AMOR (Cleve). Plate 17, fig. 62.

Cyttarocylis amor CLEVE, Öfv. Kongl. Sv. Vet.-Akad. Förhandl. **57** (1900) 970, 971, fig. 4; Kongl. Sv. Vet.-Akad. Handl. (5) **35** (1901) 10; OSTENFELD and SCHMIDT, Vidensk. Medd. **52** (1901) 178.

Ptychocylis (*Rhabdonella*) *amor* BRANDT, Ergeb. Plankton-Exp. **3** (1906) 27, pl. 54, figs. 4, 6, 12–15; (1907) 21, 327–331, 453.

Rhabdonella amor ENTZ, Arch. f. Protist. **15** (1909) pl. 12, fig. 2; KOFOID and CAMPBELL, Univ. Cal. Pub. Zool. **34** (1929) 212, fig. 398; ALZAMORA, Inst. Español Oceanog. XI (76) (1933) 9, pl. 2, fig. 21; MARSHALL, Great Barrier Reef Exp. (15) **4** (1934) 649, text fig. 26.

Lorica short-subconical, without perceptible pedicel; oral diameter about 2 in length; suboral shelf slightly flaring, oral rim thin, immergent; bowl convex, inverted-subconical, changing from about 16° orally to about 38° aborally; ribs far apart, running more or less in a left-handed spiral near aboral end, few are branched, with several rows of fenestræ between two of them.

Length, about 88 μ; oral diameter, 44 μ.

Common in Puerto Galera Bay, Mindoro.

RHABDONELLA SPIRALIS (Fol). Plate 17, fig. 63.

Tintinnus spiralis FOL, Arch. Sci. Phys. Nat. (3) **5** (1881) 21, pl. 1, fig. 4.

Cyttarocylis spiralis OSTENFELD and SCHMIDT, Vidensk. Medd. **52** (1901) 180, fig. 29; SCHMIDT, Vidensk. Medd. **52** (1901) 188.

Ptychocylis (*Rhabdonella*) *spiralis* BRANDT, Ergeb. Plankton-Exp. **3** (1906) pls. 52–54, figs. 2–7; (1907) 321, 323, 327; OKAMURA, Annot. Zool. Japon. **6** (1907) 140, pl. 6, fig. 52; ENTZ, Arch. f. Protist. **15** (1909) 109, pl. 20, fig. 2.

Rhabdonella spiralis KOFOID and CAMPBELL, Univ. Cal. Pub. Zool. **34** (1929) 219, fig. 414; HOFKER, Arch. f. Protist. **75** (1931) 378, figs. 67–74; MARSHALL, Great Barrier Reef Exp. (15) **4** (1934) 646, 647, text fig. 23.

Lorica tall, chalice-shaped, about 4.8 oral diameters in total length; oral rim only with a slight flare; bowl orally almost cylindrical, then tapering abruptly to about 28°; aboral end in the form of a long, narrow pedicel with almost straight sides, open at end; length of pedicel only slightly less than half of

total length; about 16 ribs visible from one side, straight orally, but with slight left-handed twist aborally; usually one vertical row of fenestræ between two ribs.

Total length, about 327 μ; oral diameter, 68 μ.

Often met with at Puerto Galera Bay, Mindoro.

RHABDONELLA BRANDTI Kofoid and Campbell. Plate 17, fig. 64.

Ptychocylis (*Rhabdonella*) *amor* var. *cuspidata* BRANDT, Ergeb. Plankton-Exp. 3 (1906) 27, pl. 54, figs. 3, 10, 11; (1907) 315–320, 331, 332, 453.

Rhabdonella brandti KOFOID and CAMPBELL, Univ. Cal. Pub. Zool. 34 (1929) 213, fig. 400; MARSHALL, Great Barrier Reef Exp. (15) 4 (1934) 649, text fig. 24.

Lorica chalice-shaped, of medium length, with a distinct pedicel; oral diameter about 3 in length, oral rim without visible flare; oral third of bowl more or less cylindrical, then bowl converging to about posterior third from pedicel, pedicel stout, about one-fourth of total length and closed at tip; about eighteen ribs visible from one side, usually running vertically at oral region but with slight left-handed twist basally, closely set, with one vertical row of fenestræ between two of them.

Length, about 192 μ; oral diameter, about 64 μ.

Common in Puerto Galera Bay, Mindoro.

RHABDONELLA FENESTRATA sp. nov. Plate 17, fig. 65.

Lorica small, oral diameter about 16 in total length; oral rim with a pronounced gutter between inner and outer laminæ; bowl cylindrical toward oral half, then becoming subconical, first about 65°, then contracting to about 32° to form short, blunt pedicel about 2.5 in oral diameter; ribs about 3.5, very prominent, with a slight counter-clockwise spiral; one row of well-developed fenestræ between two ribs.

Total length, about 80 μ; oral diameter, about 48 μ.

Type locality.—Puerto Galera Bay, Mindoro.

Family TINTINNIDÆ Claparéde and Lachmann

Lorica rigid, variously formed; oral region usually flaring (except *Bursaopis*); aboral end open or closed; wall hyaline, usually without secondary structure; with two, four, or eight macronuclei and micronuclei, and sixteen to twenty-four membranelles.

Genus TINTINNUS Schrank (1803)

Lorica in form of a truncated cone or cylinder, open at both ends; wall hyaline, homogenous, never with spiral structure, rarely externally wrinkled.

TINTINNUS PERMINUTUS Kofoid and Campbell. Plate 17, fig. 66.

Tintinnus lusus-undae DADAY in part, Mitt. Zool. Stat. Neapel 7 (1887) 527, 530.

Tintinnus franknoi OKAMURA in part, Annot. Zool. Japon. 6 (1907) 140, pl. 6, fig. 67*a*.

Tintinnus perminutus KOFOID and CAMPBELL, Univ. Cal. Pub. Zool. 34 (1929) 337, fig. 649.

Lorica in form of a truncated cone, 3° 6' with only a very slight median bulge; oral diameter about 4.3 in length.

Length about 177 μ.

Rarely met with in surface plankton of Manila Bay.

REFERENCES

1. ABÉ, T. H. Report of the Biological Survey of Mutsu Bay. 3. Notes on the Protozoan Fauna of Mutsu Bay. Sci. Rep. Tohoku Imp. Univ. IV 4 2 (1927) 383–438.
2. ALZAMORA, M. M. Contribución al Estudio de los Infusorios (Nota tercera). Nuevos Tintinnidos de la bahía de Palma de Mallorca. Subsecretaria de la Marina Civil. Inst. Español Oceanog. XI (76) (1933) 1–14.
3. AURIVILLUS, C. W. S. Vergleichende thiergeographische Untersuchungen über die Plankton-fauna des Skageraks in den Jahren 1893–1897. Kongl. Sv. Vet.-Akad. Handl. (3) 30 (1898) 427 pp., 15 text figs.
4. AURIVILLUS, C. W. S. Animalisches Plankton aus dem Meere zwischen Jan Mayer, Spitzbergen, K. Karls Land und der Nordküste Norwegens. Kongl. Sv. Vet.-Akad. Handl. (6) 32 (1899) 1–71.
5. BAILEY, J. W. Notes on new species and localities of microscopic organisms. Smith. Contr. Knowl. Washington 7 (1855).
6. BERGH, R. S. Der Organismus des Ciliaflagellaten. Morph. Jahrb. Leipzig 7 (1881).
7. BERGH, R. S. Der Organismus des Ciliaflagellaten. Eine Phylogenetische Studie. Morph. Jahrb. 7 (1882) 177–288.
8. BIGELOW, H. B. Plankton of the offshore waters of the Gulf of Maine. Bull. U. S. Bur. Fish. 40 (1924) 1–509.
9. BÖHM, A. Zur Verbreitung einiger Peridineen. Arch. f. Protist. (1931).
10. BÖHM, A. Distribution and variability of Ceratium in the northern and western Pacific. B. P. Bishop Mus. Bull. 87 (1931) 1–46.
11. BÖHM, A. Beobachtungen an Adriatischen Peridinium-Arten. Arch. f. Protist. (2) 80 (1933) 303–320.
12. BÖHM, A. Dinoflagellates of the coastal waters of the western Pacific. Bull. B. P. Bishop Mus. 137 (1936) 1–54.
13. BRANDT, K. Die Tintinnodeen der Plankton-Expedition. Ergeb. d. Plankton-Exped. d. Humboldt-Stiftung 3 (1906) 1–33; (1907) 3–488.
14. BROCH, H. Bemerkungen über den Formenkreis von Peridinium depressum s. lat. NYT Mag. f. Natur. 44 (1906) 151–157.
15. BROCH, H. Planktonstudien an der Mündung der Ostsee im Juli 1907. Göteborg. Swedish Hydrographic Investigations (1908).

16. BROCH, H. Die Peridinium-Arten des Nordhafens (Val di Bora) bei Rovigno im Jahre 1909. Arch. f. Protist. 20 (1910) 176–200.
17. BROCH, H. Das Plankton der schwedischen Expedition nach Spitzbergen 1908. Kongl. Sv. Vet.-Akad. Handl. (9) 45 (1910) 25–64.
18. CAMPBELL, A. S. A few dinoflagellates from Laguna beach. Journ. Ent. Zool. (2) 26 (1934) 17–21.
19. CLAPARÉDE, E., and LACHMANN, J. Etudes sur les infusoires et les rhizopodes. Mem. Inst. Nat. Genéve 5 (1858) 1–260; 6 (1859) 261–482.
20. CLEVE, P. T. Plankton collected by the Swedish Expedition to Spitzbergen in 1898. Kongl. Sv. Vet.-Akad. Handl. (3) 32 (1899) 1–51.
21. CLEVE, P. T. The plankton of the North Sea, the English Channel, and the Skagerak in 1898. Kongl. Sv. Vet.-Akad. Handl. (8) 32 (1900) 3–53.
22. CLEVE, P. T. Notes on some Atlantic plankton-organisms. Kongl. Sv Vet.-Akad. Handl. (1) 34 (1900) 1–22.
23. CLEVE, P. T. The plankton of the North Sea, the English Channel and the Skagerak in 1899. Kongl. Sv. Vet.-Akad. Handl. (2) 34 (1900) 1–77.
24. CLEVE, P. T. Plankton from the southern Atlantic and the southern Indian Ocean. Öfv. Kongl. Sv. Vet.-Akad. Förhandl. 57 (1900).
25. CLEVE, P. T. Plankton from the Red Sea. Öfv. Kongl. Sv. Vet.-Akad. Förhandl. (9) 57 (1900) 1025–1038.
26. CLEVE, P. T. Plankton from the Indian Ocean and the Malay Archipelago. Kongl. Sv. Vet.-Akad. Handl. (5) 35 (1901) 1–58.
27. CLEVE, P. T. The plankton of the North Sea and the Skagerak in 1900. Kongl. Sv. Vet.-Akad. Handl. (7) 35 (1902) 1–49.
28. CLEVE, P. T. Additional notes on seasonal distribution of Atlantic plankton organisms. Göteborg Vet. Handl. IV 4 (1902) 1–51.
29. CLEVE, P. T. Plankton researches in 1901–1902. Kongl. Sv. Vet.-Akad. Handl. (8) 36 (1903) 53 pp.
30. CLEVE, P. T. Report on plankton collected by Mr. Thorild Wulff during a voyage to and from Bombay. Ark. f. Zool. 1 (1903) 329–381.
31. DADAY, E. VON. Monographie der Familie der Tintinnodeen. Mitt. Zool. Stat. Neapel 7 (1887) 473–591, 18–21 pls.
32. DANGEARD, P. Phytoplancton de la Croisiere du Sylvana (Feb.-Juin, 1913). Ann. L'Inst. Oceanog. (1927).
33. EHRENBERG, C. G. Die Infusionsthierchen als vollkommene Organismen. Ein Blick in das tiefere organische Leben der Natur. Leipzig 18 (1838) 541 pp., 11 pls.
34. EHRENBERG, C. G. Beobachtung von 274 Infusorien-Arten. Bericht über Verhandl. d. Berliner Akad. d. Wiss. (1840).
35. EHRENBERG, C. G. Die Systematische Characteristik der neuen mikroskopischen Organismen des tiefen atlantischen Oceans. Monatsber. Akad. Wiss. Berlin (1854) 236–250.
36. EHRENBERG, C. C. Über der Leuchten und über neue mikroskopische Leuchttiere des Mittelmeeres. Monatsber. der Berliner Akad. d. Wiss. (1859).

37. ENTZ, G. Studien über Organisation und Biologie der Tintinniden. Arch. f. Protist. 15 (1909) 93–226.
38. FAURÉ-FREMIET, E. Etude descriptive des peridiniens et des infusoires cilies, du plankton de la Baie de la Houghe. Ann. Sci. Natur. IX 7 (1908) 209–240.
39. FAURÉ-FREMIET, E., and O. DU PUIGAUDEAU. Le microplankton de la Baie du Croisic. Bull. Soc. Zool. France (10) 47 (1922) 430–458.
40. FAURÉ-FREMIET, E., and O. DU PUIGAUDEAU. Le Microplankton de la Baie du Croisic. (4, 5) 48 (1923) 258–271.
41. FOL, H. Contribution a la connaissance de la famille des Tintinnodea. Arch. Sci. Phys. Nat. (3) 5 (1881) pls. 5–24.
42. GOURRET, P. Sur les Peridiniens du Golfe de Marseilles. Ann. Mus. d'Hist. Nat. Marseilles. Zool. (8) 1 (1883) 114 pp.
43. HADA, Y. Descriptions of two new neritic Tintinnoinea, Tintinnopsis japonica and Tps. kofoidi with a brief note on a unicellular organism parasitic on the latter. Proc. Imp. Acad. (5) 8 Japan (1932) 209–212.
44. HADA, Y. Studies on the Tintinnoinea from the western tropical Pacific. Journ. Fac. Sci. Hokkaido Imp. Univ. VI Zool. (2) 6 (1938) 87–190.
45. HOFKER, J. Studien über Tintinnoinea. Arch. f. Protist. 75 (1931) 315–402.
46. IMHOF, O. E. Ueber microscopische pelagische Thiere aus den Lagunen von Venedig. Zool. Anz. 9 (1886) 101–104.
47. JOLLOS, V. Dinoflagellenstudien. Arch. f. Protist. 19 (1910) 178–206.
48. JÖRGENSEN, E. Bericht über die von der schwedischen Hydrographisch-biologischen Kommission in den schwedischen Gewässern in den Jahren 1909–1910 eingesammelten Planktonproben. Skr. Schw. Hydrog.-biol. Komm. Göteborg 4 (1912) 20 pp.
49. JÖRGENSEN, E. Mediterranean Tintinnidae. Rep. Danish Oceanog. Exped. 1908–1910 to Mediterranean and adjacent seas. Biol. 2 (1924) 110 pp., 114 text figs.
50. JÖRGENSEN, E. "Ciliata-Tintinnidae" in Grimpe. G., and Wagler, E., Die Tierwelt der Nord-und Ostsee. pt. 2 8 (1927) 1–26, 33 text figs.
51. KARSTEN, G. Das Phytoplankton des Atlantischen Oceans nach dem Material der deutschen Tiefsee Expedition 1898–1899. Deuts. Tiefsee Exped. 1898–1899 pt. 2 2 (1906) 137–219.
52. KARSTEN, G. Das Indische Phytoplankton. Nach dem Material der Deutschen Tiefsee-Expedition 1898–1899. Wiss. Ergeb. d. Deuts. Tief. Exped. a. d. Dampfer "Valdivia" 1898–1899 2 (1907) 221–548.
53. KENT, W. S. A Manual of the Infusoria. London (1880–1881) 913 pp., 51 pls.
54. KOFOID, C. A. New species of dinoflagellates. Bull. Mus. Comp. Zool. Cambridge (6) 1 (1907).
55. KOFOID, C. A. Dinoflagellata of the San Diego Region, III. Descriptions of new species. Univ. Cal. Pub. Zool. (13) 3 (1907) 299–340.
56. KOFOID, C. A. The Morphology of the Skeleton of Podolampas. Arch. f. Protist. 16 (1909) 48–60.

57. KOFOID, C. A. Dinoflagellata of the San Diego Region, IV. The Genus Gonyaulux, with notes on its skeletal morphology and a discussion of its generic and specific characters. Univ. Cal. Pub. Zool. (4) 8 (1911) 187–286.
58. KOFOID, C. A., and A. S. CAMPBELL. A conspectus of the marine and fresh-water Ciliata belonging to the suborder Tintinnoinea, with descriptions of new species principally from the Agassiz Expedition to the Eastern Tropical Pacific 1904–1905. Univ. Cal. Pub. Zool. 34 (1929) 1–403.
59. KOFOID, C. A., and T. SKOGSBERG. The Dinoflagellata: The Dinophysoidae. Mem. Mus. Comp. Zool. Harv. 51 (1928) 1–766.
60. LAACKMANN, H. Die Tintinnideen der deutschen Südpolar Expedition 1901–1903. Deuts. Südp. Exped. 11 (1909) 340–396, pls. 33–51.
61. LEBOUR, M. V. The microplankton of Plymouth Sound from the region beyond the breakwater. Journ. Mar. Biol. Ass. 11 (1917) 133–182.
62. LEBOUR, M. V. The Peridiniales of Plymouth Sound from the region beyond the breakwater. Journ. Mar. Biol. Ass. 11 (1917) 183–200.
63. LEBOUR, M. V. Plymouth peridiniens. Journ. Mar. Biol. Ass. 12 (1919–1922) 795–818.
64. LEBOUR, M. V. The dinoflagellates of northern seas. Plymouth Mar. Biol. Lab. (1925) 172 pp.
65. LINDEMANN, E. Peridineen aus dem Goldenen Horn und dem Bosporus. Bot. Arch. 5 (1923) 216–233.
66. LINDEMANN, E. Abteilung Peridineae (Dinoflagellatae). Die Natürlichen Pflanzenfamilien 2 (1928) 3–104.
67. MANGIN, L. Modifications de la cruisse chez quelques Peridiniens. Intern. Rev. Hydrobiol. Leipzig 4 (1911).
68. MANGIN, L. Sur la flore planctonique de la rade de St. Vaast.—la Hougue 1908–1912. Nouv. Arch. Mus. Hist. Nat. Paris V 5 (1913) 147–241.
69. MARSHALL, S. M. The Silicoflagellata and Tintinnoinea. Brit. Mus. (Nat. Hist.) Great Barrier Reef Exped. 1928–1929 (15) 4 (1934) 623–664.
70. MATZENAUER, L. Die Dinoflagellaten des Indischen Ozeans. Botanisches Archiv 35 (1933) 437–508.
71. MEUNIER, M. A. Microplankton des Mers de Barents et de Kara. Duc D'Orleans Campagne Arctique de 1907. 1 (1910) 355 pp., 37 pls.
72. MEUNIER, M. A. Microplankton de la Mer Flamande. Mem. Mus. Roy. d'Hist. Nat. Belgique pt. 3 8 (1919) 3–116.
73. MEUNIER, M. A. Microplankton de la Mer Flamande. Mem. Mus. Roy. d'Hist. Nat. Belgique pt. 4 8 (1919) 3–59.
74. MÜLLER, O. F. Zoologiae danicae prodromus. Hauniae (1777; 1781).
75. MURRAY, G., and F. G. WHITING. New Peridiniaceae from the Atlantic. Trans. Linn. Soc. London II 5 (1895–1901) 321–338.
76. NIELSEN, E. S. Die Ceratienarten im südlichen Stillen Ozean. The Carlsberg Foundation's Oceanographical Expedition Round the World 1928–1930 and previous Dana-Expeditions. Dana-Report No. 4 (1934) 1–67.

77. NITZSCH, C. L. Beitrag zur Infusorkunde oder Naturbeschreibung der Zerkerien und Bazillarien, Neue Schriften d. naturf. Ges. zu Halle 3 (1817).
78. OKAMURA, K. An annotated list of plankton microorganisms of the Japanese coast. Annot. Zool. Japon. 6 (1907) 125–151.
79. OKAMURA, K. Plankton organisms from bonito fishing grounds. Rep. Imp. Bur. Fish 1 (1912) 4–38.
80. OKAMURA, K., and T. NISHIKAWA. A list of the species of Ceratium in Japan. Annot. Zool. Japon. 5 (1904) 121–131.
81. OSTENFELD, C. H., and J. SCHMIDT. Plankton fra det Rode Hav og Adenbugten. (Plankton from the Red Sea and the Gulf of Aden). Vidensk. Medd. 52 (1901) 141–182.
82. PAULSEN, O. Plankton investigations in the waters around Iceland in 1903. Medd. Komm. Havunders. Kopenhagen. I. Plankton (1) 1 (1904) 39 pp.
83. PAULSEN, O. On some Peridiniae and plankton diatoms. Medd. Komm. Havunders. Kopenhagen. Plankton (3) 1 (1905).
84. PAULSEN, O. The Peridiniales of the Danish waters. Medd. Komm. Havunders. Kopenhagen (5) 1 (1907) 26 pp.
85. PAULSEN, O. Nordisches Plankton. Peridiniales 17 (1908) 124 pp.
86. PAULSEN, O. Etudes sur le microplancton de la mer d'Alboran. Trabajos No. 4 (1930) 1–108.
87. PAVILLARD, J. Recherches sur la flore pelagique d'etang de Thau. Trav. Inst. Bot. Univ. Montpellier (1905) 116 pp.
88. PAVILLARD, J. Sur les Ceratium du Golfe du Lion. Bull. Soc. Bot. France 54 (1907) 148–155, 225–231.
89. PAVILLARD, J. Sur les peridiniens du Golfe du Lion. Bull. Soc. Bot. France 56 (1909) 277–284.
90. PAVILLARD, J. Recherches sur les peridiniens du Golfe du Lion. Trav. Inst. Bot. Univ. Montpellier. Cette. S. mixte. Mem. 4 (1916) 9–70.
91. PAVILLARD, J. A propos de la systematique des peridiniens. Bull. Soc. Bot. France 70 (1923) 876–882.
92. PAVILLARD, J. Phytoplankton (diatomees, peridiniens) provenant des campagnes scientifiques de S. A. S. le Prince Albert I^er de Monaco. Resultats des Campagnes Scientifiques 82 (1931) 3–207.
93. POUCHET, G. Contribution a l'histoire naturelle du Cilioflagelles. Journ. Anat. Physiol. Paris 19 (1883) 399–455.
94. SCHILLER, J. Die planktischen Vegetationen des adriatischen Meeres. C. Dinoflagellata. Arch. f. Protist. 61 (1928) 45–90.
95. SCHMIDT, J. Some Tintinnodea from the Gulf of Siam. Vidensk. Medd. 52 (1901) 183–190.
96. SCHRÖDER, B. Das Phytoplankton des Golfes von Neapel nebst vergleichenden Ausblicken auf das des Atlantischen Oceans. Mitt. aus d. Zool. Stat. Neapel 14 (1900) 1–38.
97. SCHÜTT, F. R. Die Peridineen den Plankton Expedition pt. 1. Studien über die Zellen der Peridineen. Ergeb. d. Plankton Exped. 4 (1895) 170 pp.
98. SCHÜTT, F. R. Peridiniaceae. Die natürlichen Pflanzenfamilien pt. 1b 1 (1896) 1–30.

99. STEIN, F. R. VON. Der Organismus der Infusionsthiere nach eigenen Forschungen in systematischer Reihenfolge bearbeitet 3 2. Hälfte. Die Naturgeschichte der arthrodelen Flagellaten. Leipzig (1883) 1–81.

100. TAI, LI-SUN, and T. SKOGSBERG. Studies on the Dinophysoidae, marine armored dinoflagellates of Monterey Bay, California. Arch. f. Protist. (3) 82 (1934) 380–482.

101. WANG, C. C., and D. NIE. A survey of the marine Protozoa of Amoy. Cont. Biol. Lab. Sci. Soc. China (9) 8 (1932) 285–385.

102. WEBER VAN BOSSE, A. Etudes sur les Algues de L'Archipel Malaisien. Ann. d. Jard. Bot. d. Buit. II 2 (1901) 128–142.

ILLUSTRATIONS

[In Plates 1 to 11, *a*, ventral view; *b*, dorsal view; *c*, apical view; *d*, abapical view; *e*, lateral view.]

PLATE 1

FIG. 1, *a*, *c*, and *d*. *Peridiniopsis asymmetrica*; × 720.
2, *a*, *c*, and *d*. *Diplopseltopsis minor*; × 808.

PLATE 2

FIG. 3, *c* and *d*. *Goniaulux polyedra*; × 565.
4, *a* and *d*. *Goniaulux digitale*; × 842.
5, *a* and *b*. *Podolampas bipes*; × 565.

PLATE 3

FIG. 6, *a* to *d*. *Peridinium conicoides*; × 585.
7, *a* to *e*. *Peridinium latissimum*; × 585.

PLATE 4

FIG. 8, *a* to *e*. *Peridinium leonis*; × 610.
9, *a* to *d*. *Peridinium subinerme*; × 610.

PLATE 5

FIG. 10, *a* to *d*. *Peridinium depressum*; × 326.
11, *a* to *d*. *Peridinium obtusum*; × 652.

PLATE 6

FIG. 12, *a*, *b*, *d*, and *e*. *Peridinium venustum*; × 493.
13, *a*, *c*, and *d*. *Peridinium africanoides*; × 493.

PLATE 7

FIG. 14, *a*, *b*, and *d*. *Peridinium divergens*; × 540.
15, *a* to *d*. *Peridinium curtipes*; × 540.

PLATE 8

FIG. 16, *a* to *d*. *Peridinium pellucidum*; × 630.
17, *a* and *b*, *Ceratium furca*; × 281.
18, *a*. *Ceratium candelabrum*; × 374.
19, *a* and *b*. *Ceratium pentagonum*; × 374.

PLATE 9

FIG. 20, *a*. *Ceratium dens*; × 436.
21, *a* and *b*. *Ceratium fusus*; × 436.
22, *a* and *b*. *Ceratium tripos*; × 326.

PLATE 10

FIG. 23, *a*. *Ceratium breve;* × 360.
24, *a*. *Ceratium macroceros;* × 360.
25, *a*. *Ceratium trichoceros;* × 270.

PLATE 11

FIG. 26, *a*. *Ceratium contrarium;* × 382.
27, *a*. *Ceratium molle;* × 382.

PLATE 12

FIG. 28. *Phalocroma rotundatum;* × 630.
29. *Phalocroma cuneus;* × 374.
30. *Phalocroma mitra;* × 593.
31. *Phalocroma doryphorum;* × 593.
32. *Dinophysis miles* fo. *indica;* × 374.
33. *Dinophysis caudata; a*, var. *abbreviata; b*, var. *pedunculata;* × 593.
34. *Dinophysis hastata;* × 593.

PLATE 13

FIG. 35, *a* to *c*. *Tintinnidium primitivum; a, b*, aboral view; *c*, oral view, × 505.
36. *Tintinnidium cylindrica*, × 505.
37, *a, b*. *Tintinnidium ampullarum; b*, oral view, × 505.
38, *a, b*. *Leprotintinnus nordquisti*, slender form; × 287.
38, *c*. *Leprotintinnus nordquisti*, stout form; × 573.
39. *Leprotintinnus tubulosus;* × 573.

PLATE 14

FIG. 40. *Tintinnopsis bacoorensis;* × 540.
41. *Tintinnopsis bütschlii;* × 540.
42. *Tintinnopsis gracilis;* × 606.
43. *Tintinnopsis loricata;* × 540.
44. *Tintinnopsis manilensis;* × 540.
45. *Tintinnopsis radix;* × 270.
46. *Tintinnopsis tocantinensis;* × 540.
47. *Tintinnopsis turgida;* × 540.

PLATE 15

FIG. 48. *Tintinnopsis major;* × 570.
49. *Tintinnopsis mortensenii;* × 360.
50. *Codonellopsis ostenfeldi;* × 540.
51. *Coxliella longa;* × 606.
52. *Favella simplex;* × 360.
53. *Favella philippinensis;* × 270.
54. *Favella elongata;* × 215.
55. *Favella azorica;* × 360.

PLATE 16

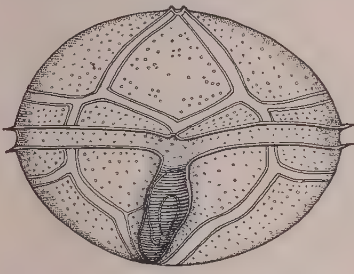
FIG. 56. *Epiplocylis exquisita;* × 659.
57. *Epiplocylis ralumensis;* × 659.
58. *Epiplocylis undella;* × 659.
59. *Metacylis hemisphærica;* × 624.
60. *Metacylis kofoidi;* × 624.
61. *Petalotricha major;* × 416.

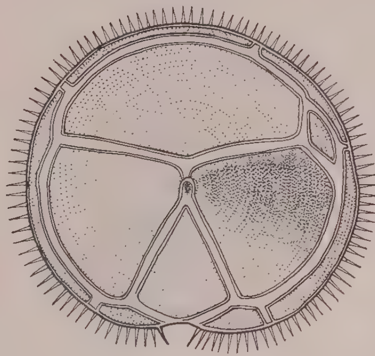
PLATE 17

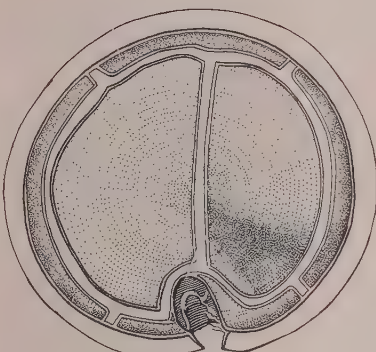
FIG. 62. *Rhabdonella amor;* × 760.
63. *Rhabdonella spiralis;* × 293.
64. *Rhabdonella brandti;* × 293.
65. *Rhabdonella fenestrata;* × 760.
66. *Tintinnus perminutus;* × 720.

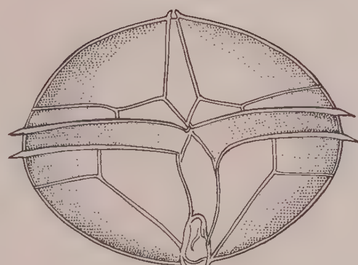
TEXT FIGURES

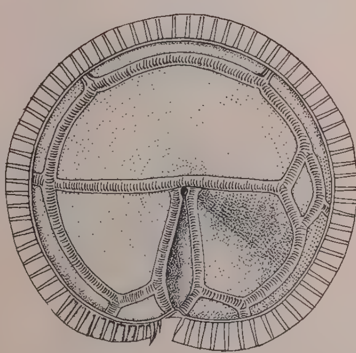
FIG. 1. Number of intercalaries and their relation to the precingulars in the groups *Orthoperidinium*, *Metaperidinium*, and *Paraperidinium*.
2. Number of intercalaries in their relation to the precingulars in the subgenera of *Peridinium*.


1a


1c


1d


2a


2c

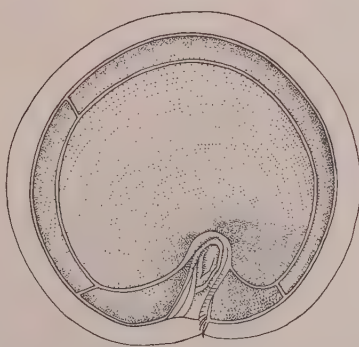

2d

PLATE 1.

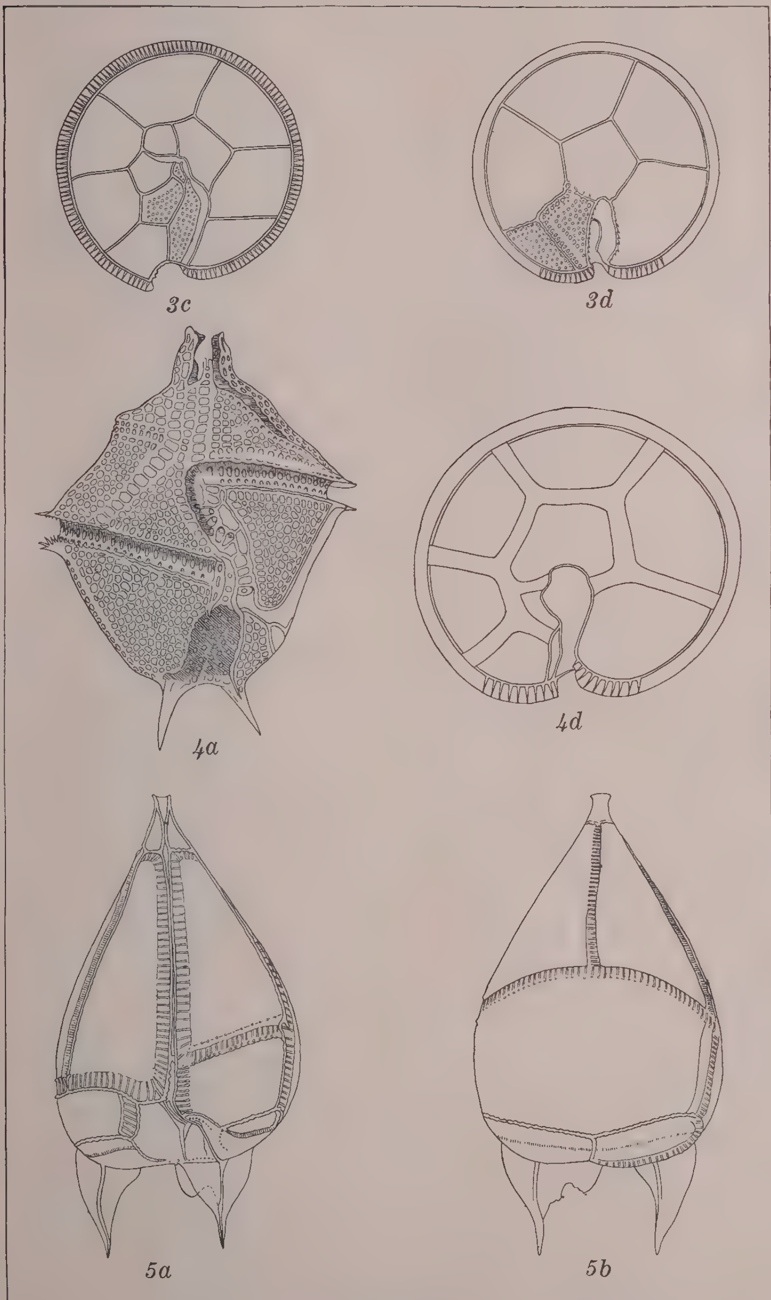


PLATE 2.

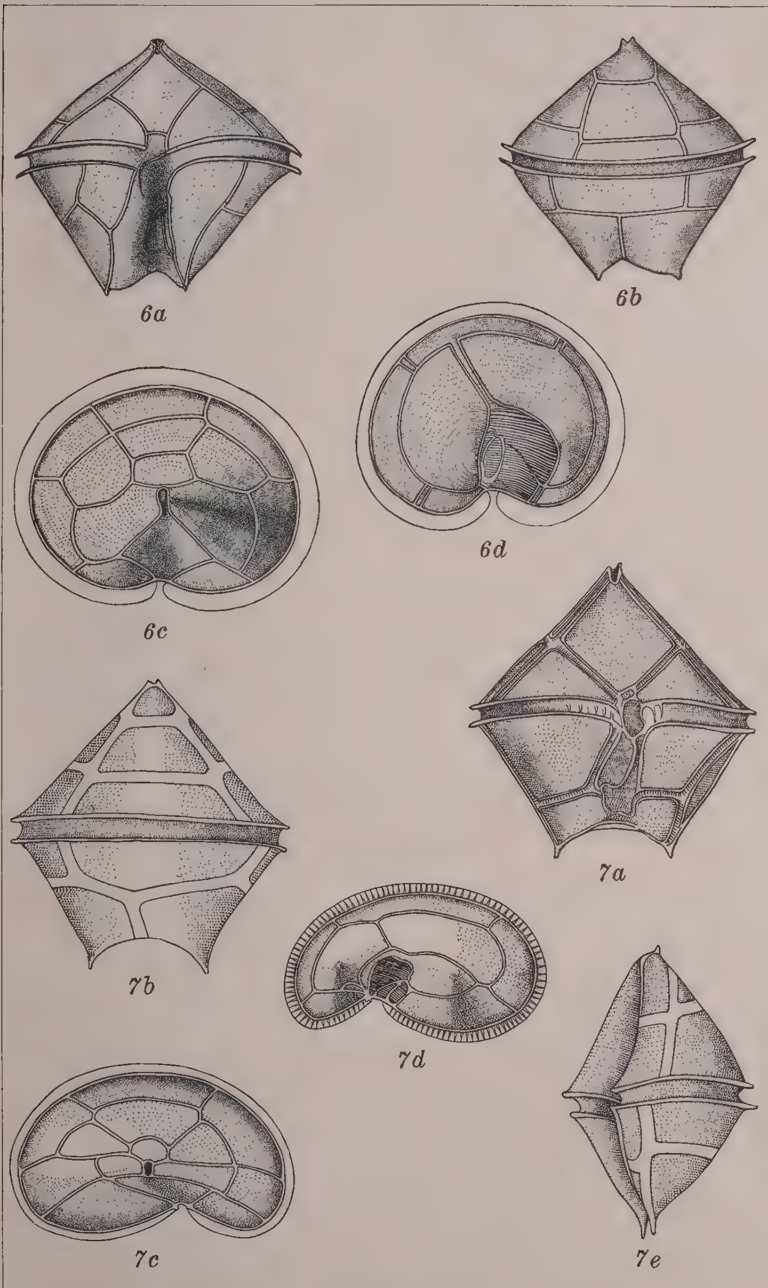


PLATE 3.

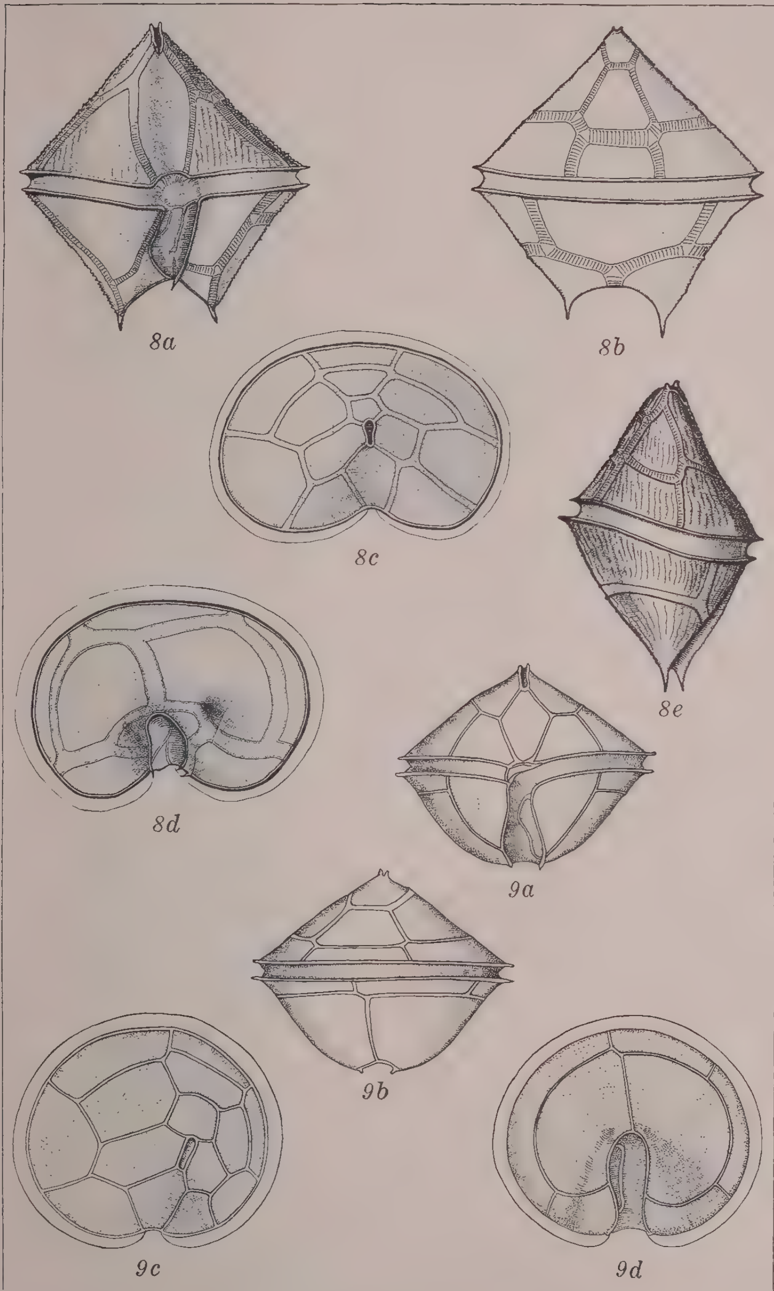


PLATE 4.

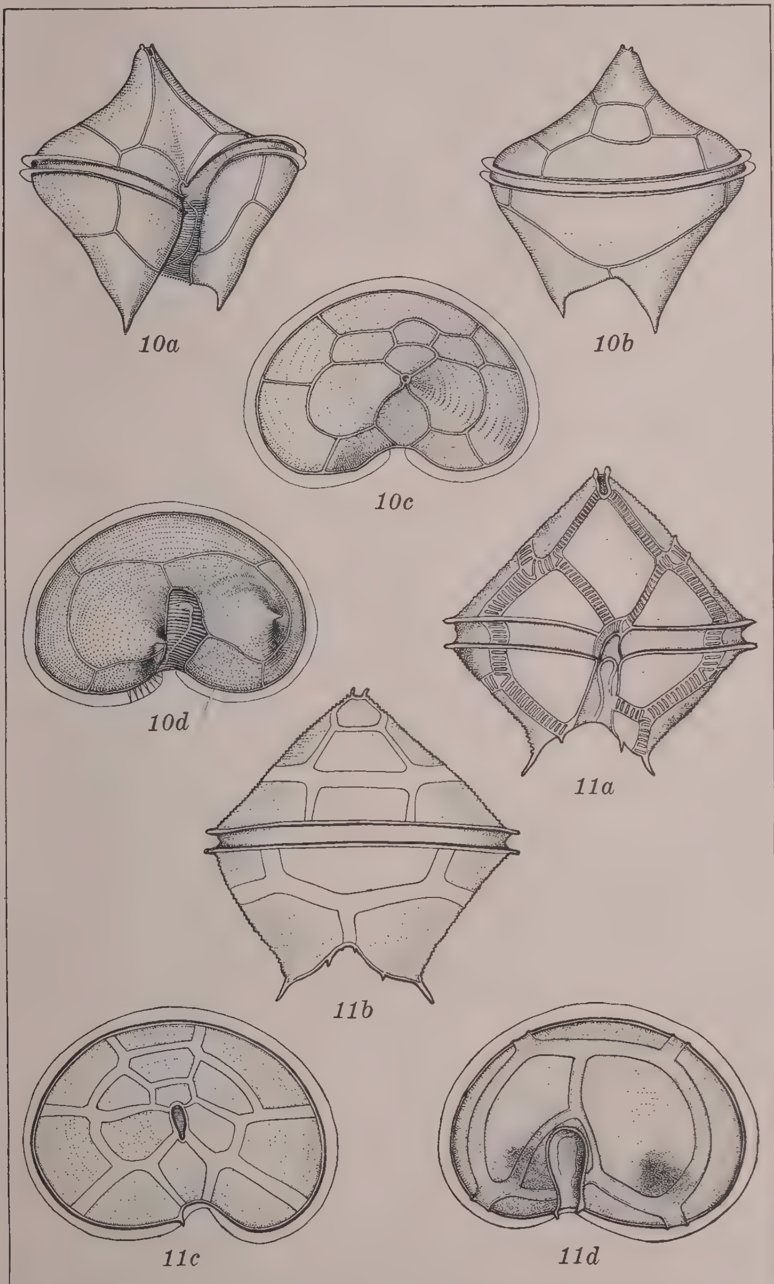


PLATE 5.

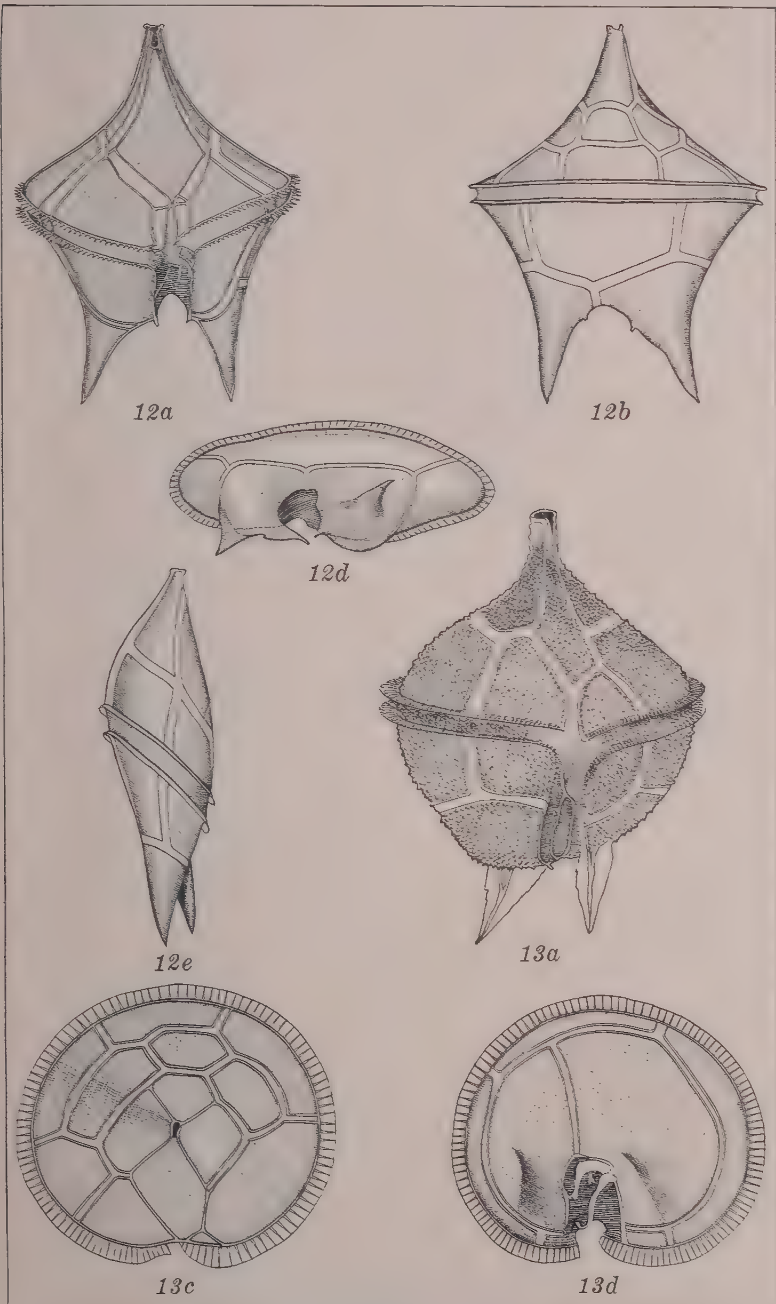
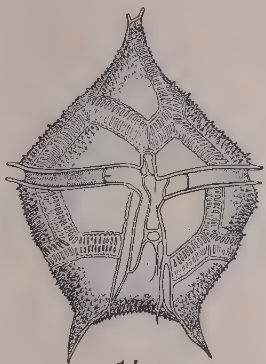
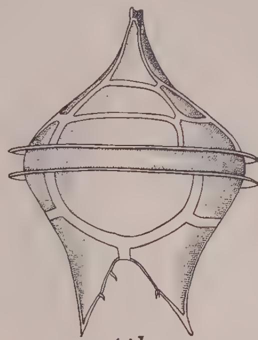


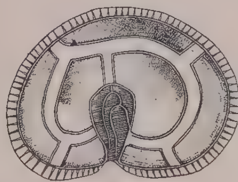
PLATE 6.



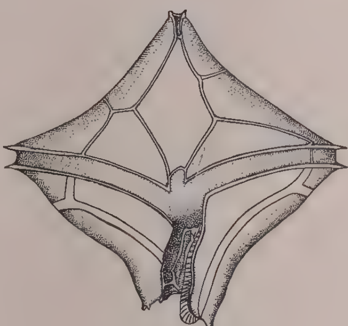
14a



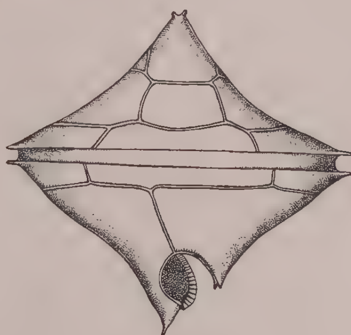
14b



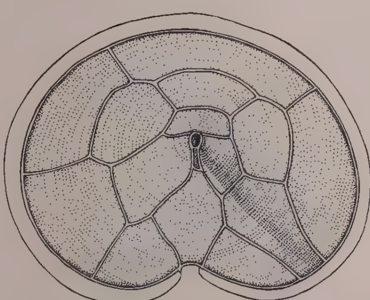
14d



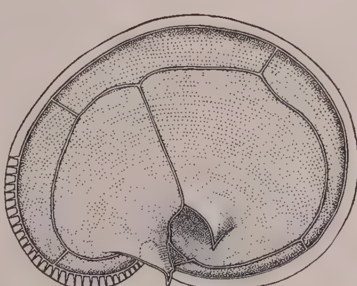
15a



15b



15c



15d

PLATE 7.

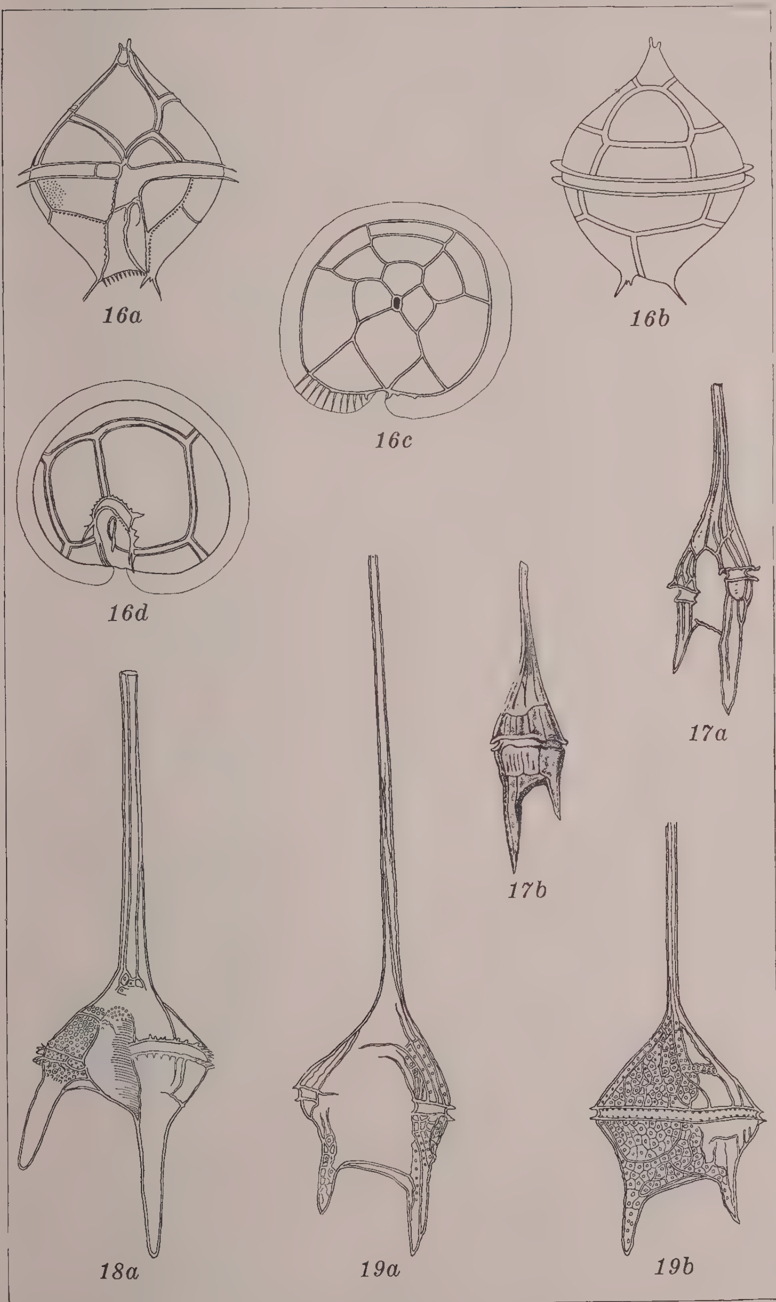


PLATE 8.

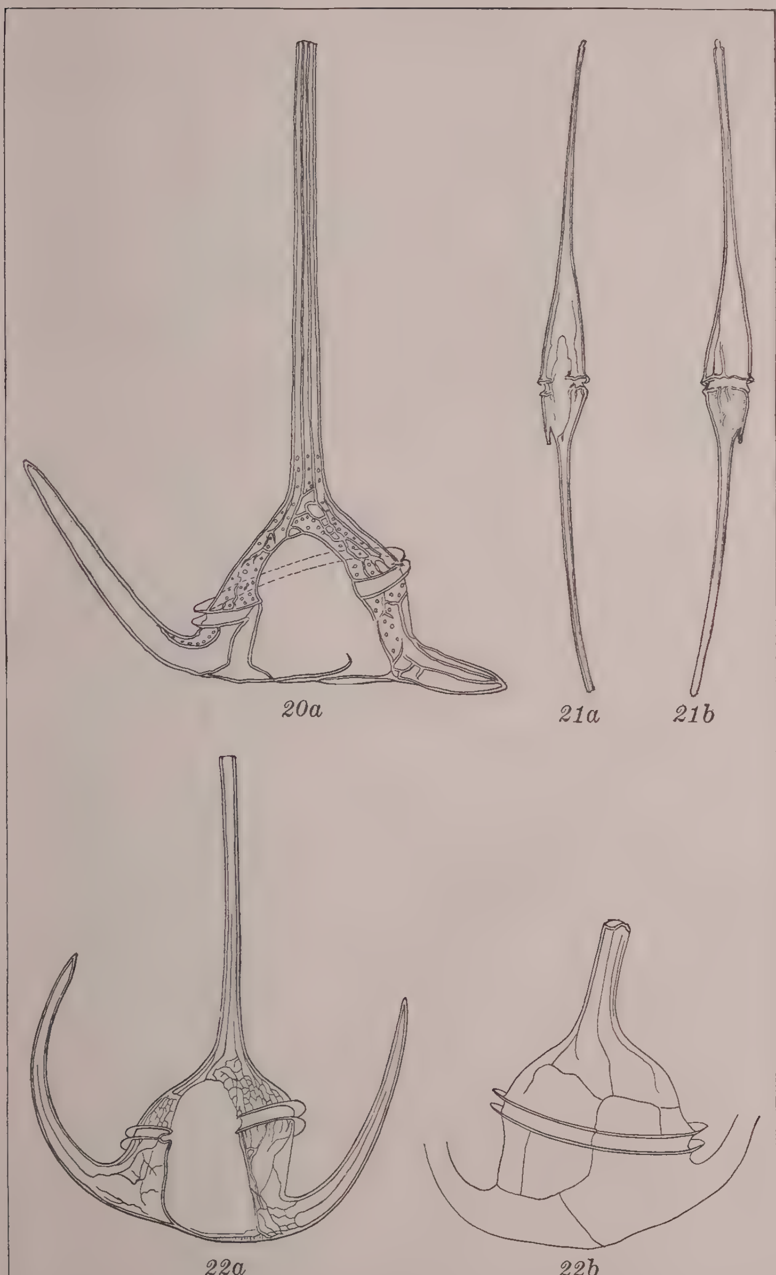
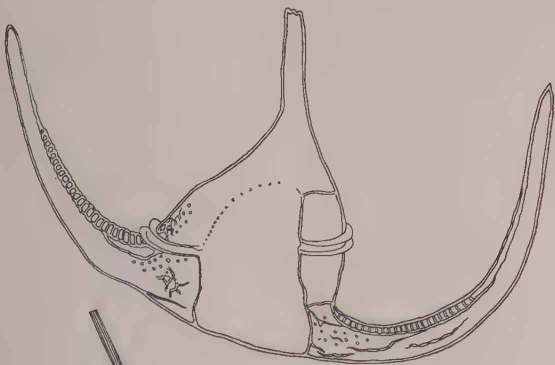
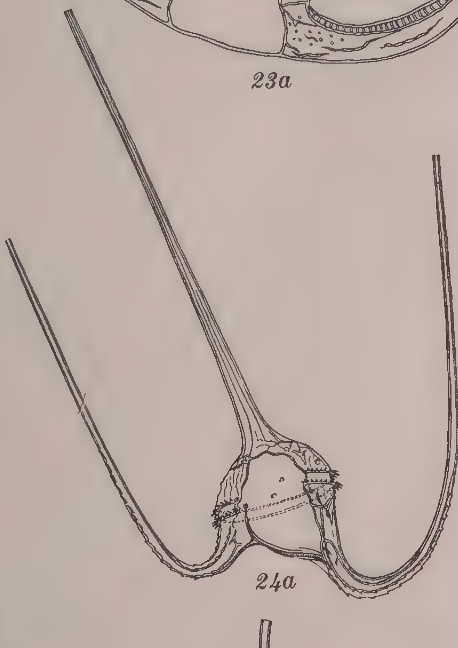


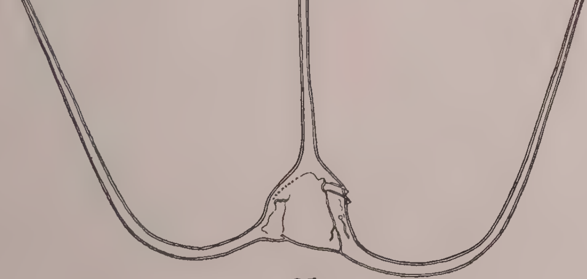
PLATE 9.



23a

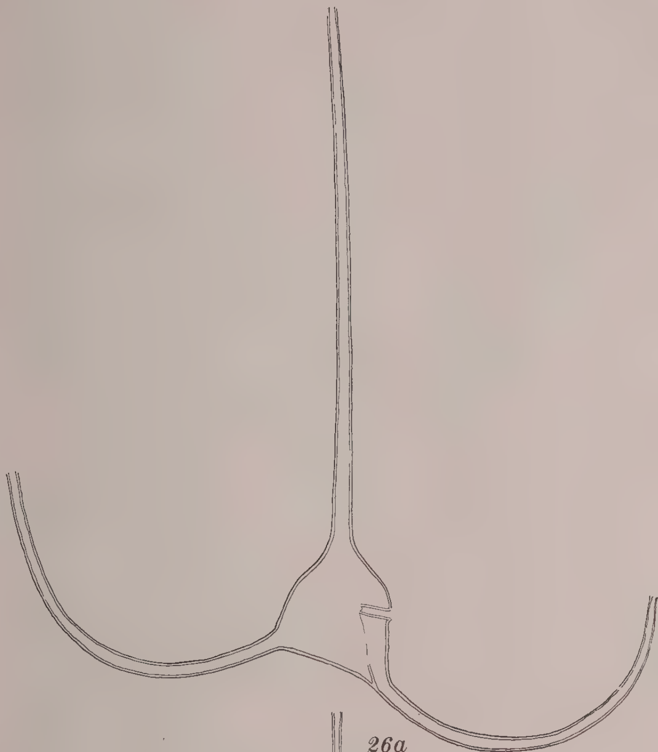


24a

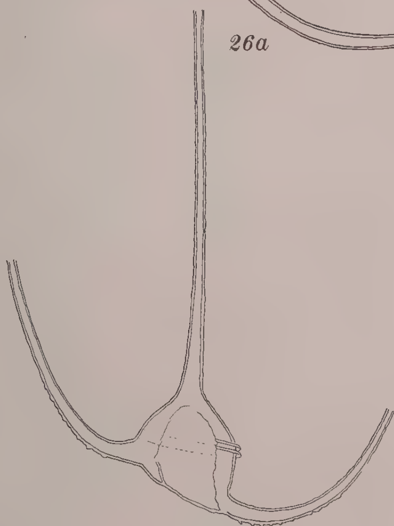


25a

PLATE 10.



26a



27a

PLATE 11.

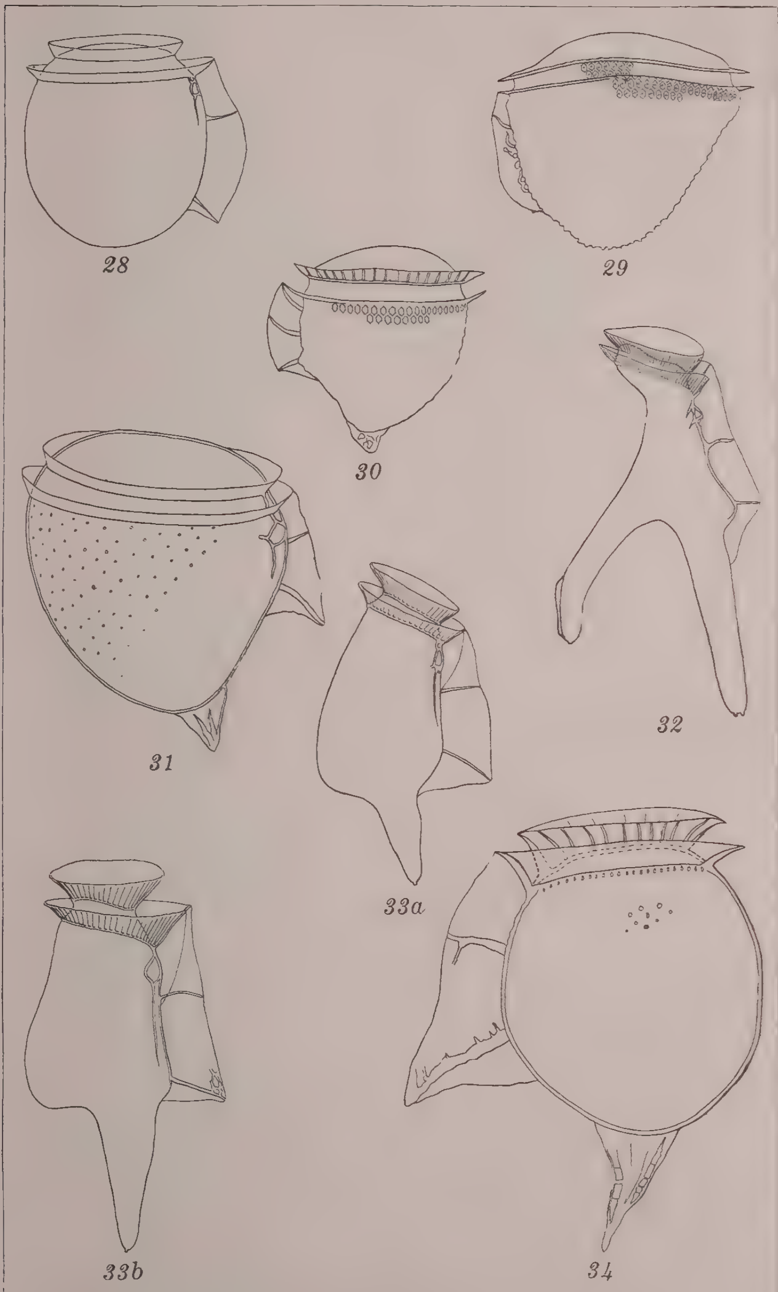


PLATE 12.

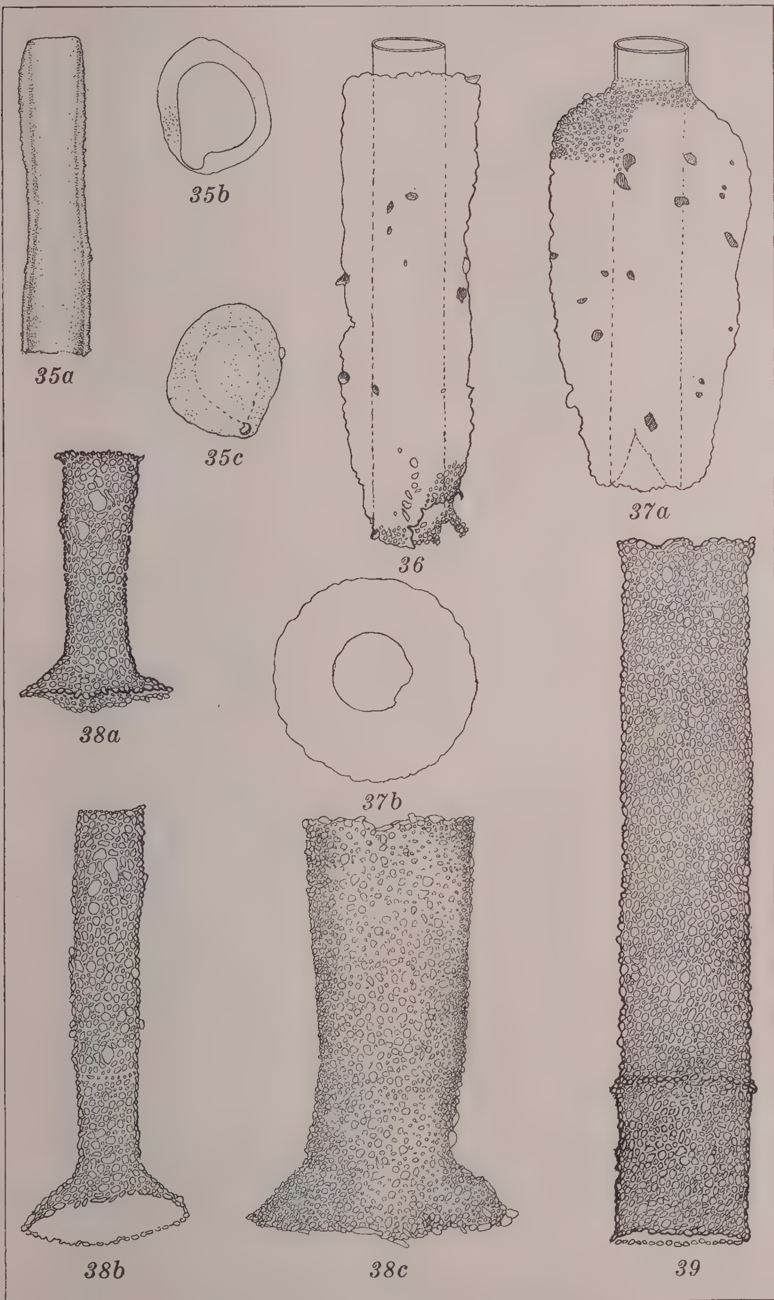


PLATE 13.

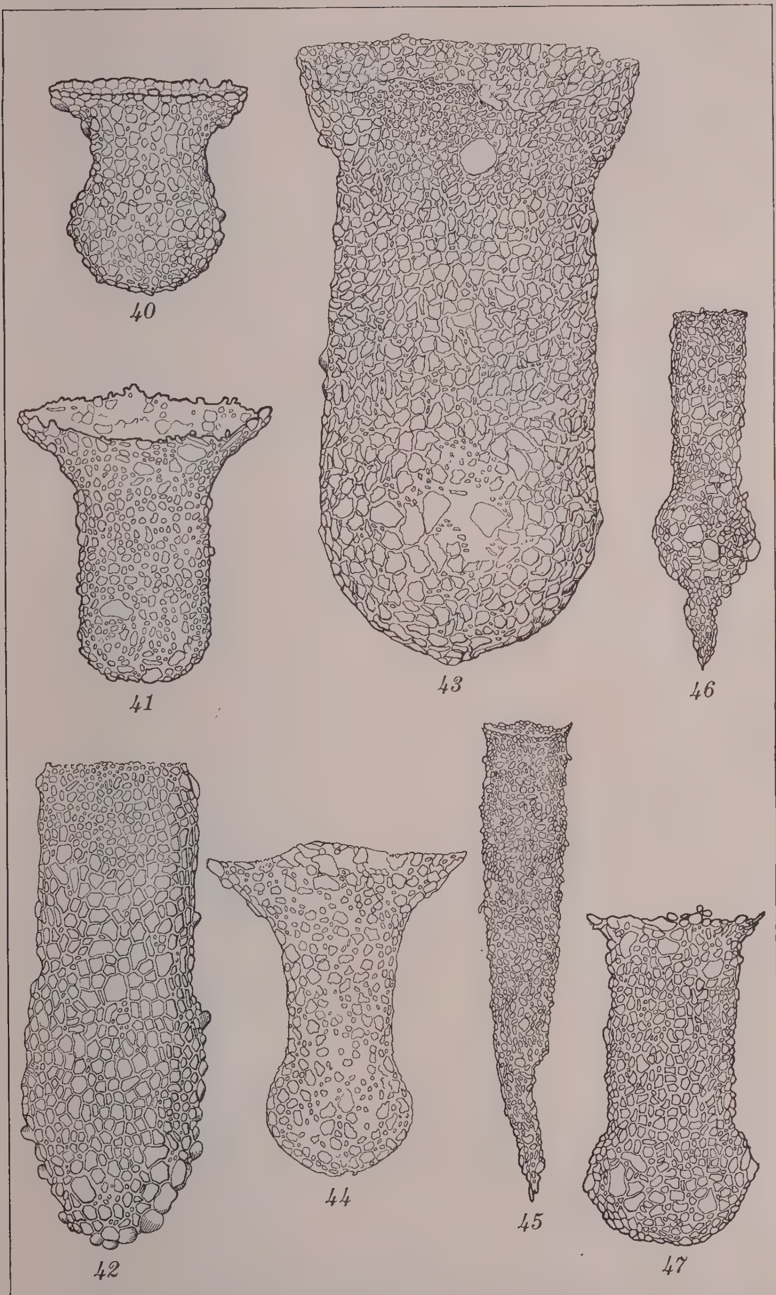


PLATE 14.

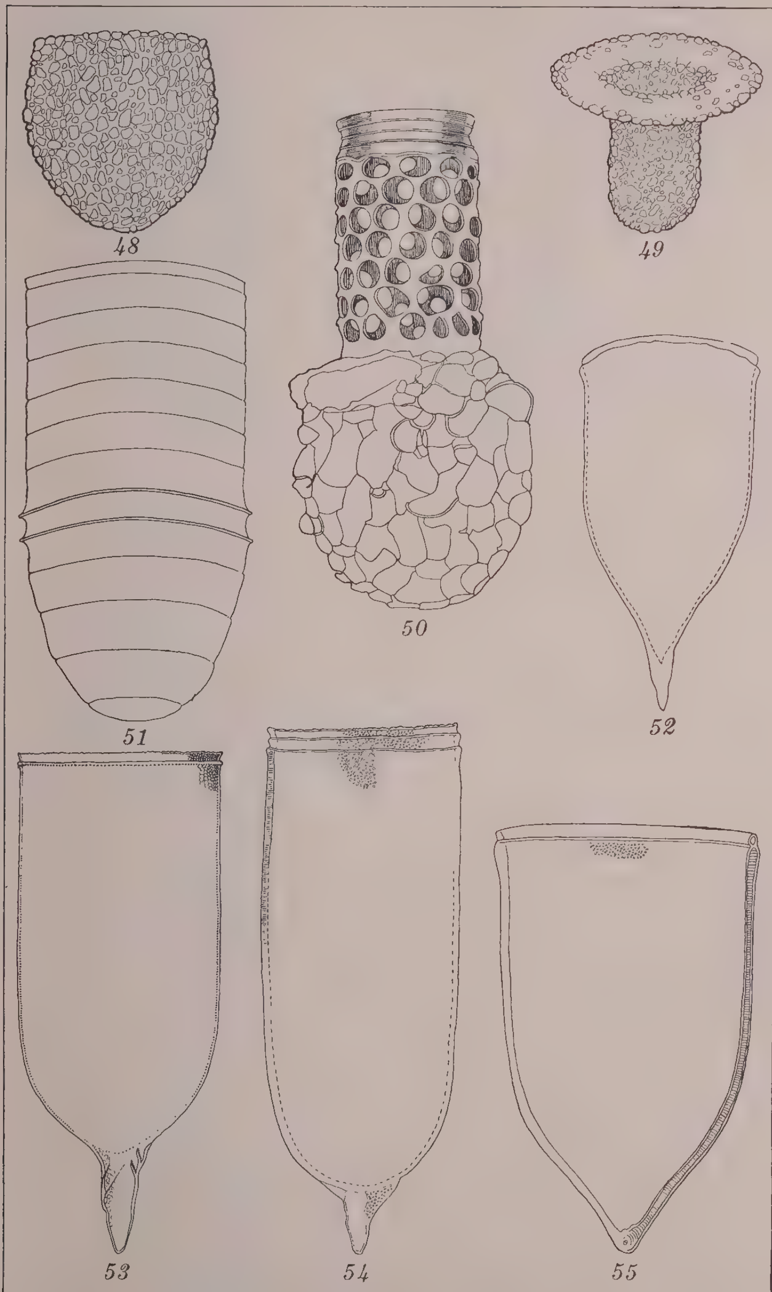


PLATE 15.

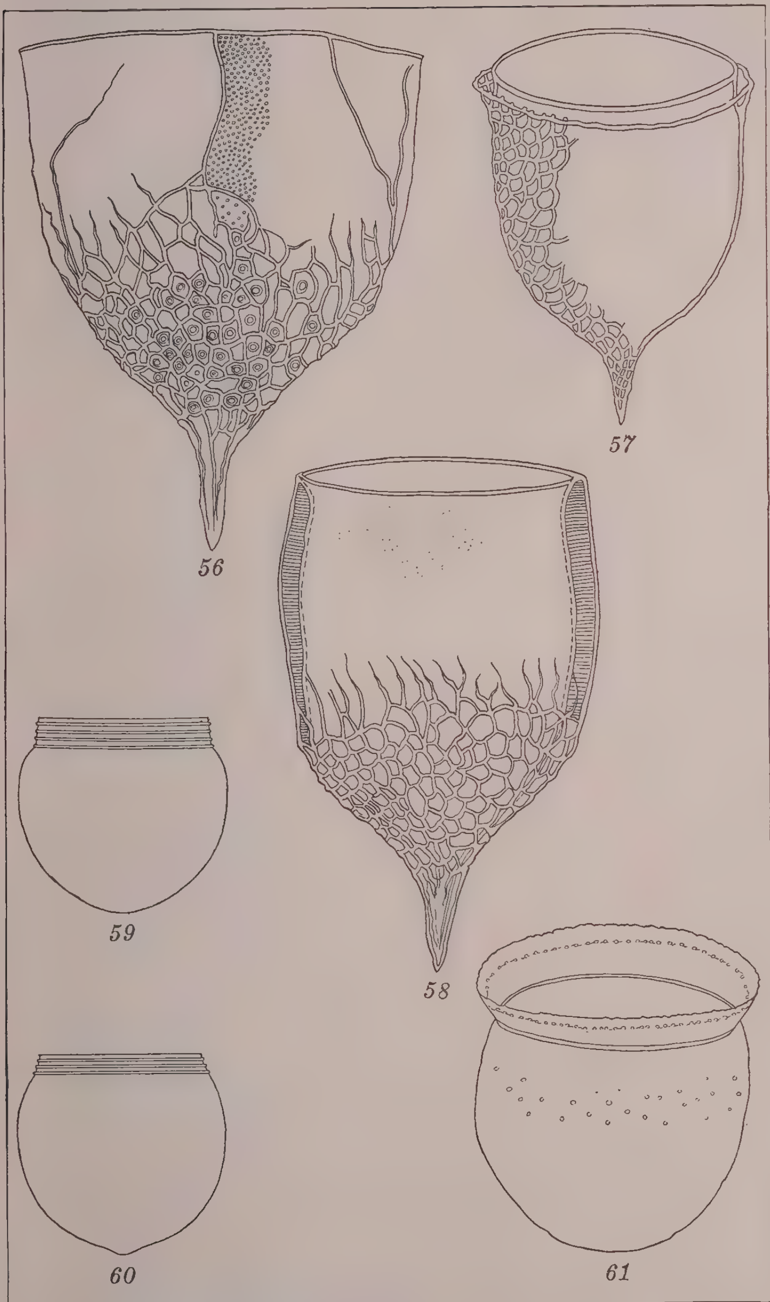
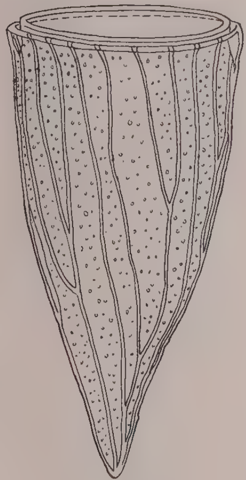


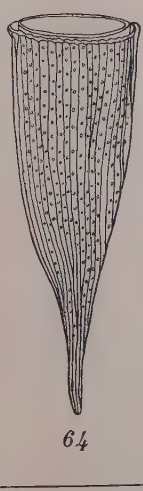
PLATE 16.



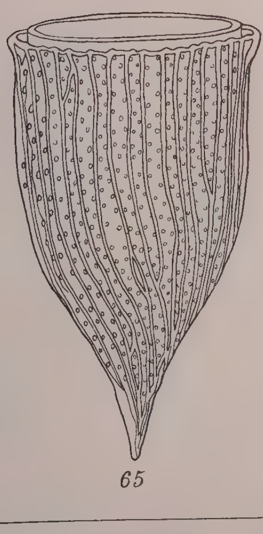
62

63

66



64



65

PLATE 17.

MORE ODONATA FROM THE PHILIPPINES

By JAMES G. NEEDHAM and MAY K. GYGER
Of Cornell University, Ithaca

ONE PLATE

Since the completion of our monograph on the Odonata of the Philippines, published in the Philippine Journal of Science,[1] there has become available to us some new material, further illustrating the richness of the odonate fauna of these Islands. Some additional specimens came from Doctor Uichanco in Los Baños, but much more was found in the Museum of Comparative Zoology at Cambridge, Massachusetts, and was made available to us through the kindness of Dr. Nathan Banks. The latter material was collected by Mr. C. S. Clagg in 1927 in Mindanao. It includes a number of new species, as well as odds and ends that amplify our knowledge of species previously described.

New species described in the present paper are: *Diplacina lisa* from Luzon; and *Prionecnemis atripes*, *Prionocnemis tendipes*, *Drepanosticta aries*, *Drepanosticta taurus*, and *Teinobasis ranee* from Mindanao. The amplified descriptions of species heretofore known from one sex are: *Indæschna balugas* Needham and Gyger, female; *Pericnemis incallida* Needham and Gyger, female; and *Pericnemis lestoides* Brauer. There are also a number of new records that extend the knowledge of the range and altitude; the more important of these are: *Heteronaias heterodoxa* Selys, a fine series from Mount Apo in Mindanao, collected in September and November at an altitude of 6,000 feet; *Heliogomphus bakeri* Laidlaw, a single pair from Mindanao; *Idionyx philippa* Ris, one female, also from Mount Apo; *Lyriothemis cleis* Brauer, a single female from Calian, Davao Province, Mindanao.

We have deemed it advisable to continue to apply generic names as in the monograph, to which this paper is merely a supplement. Hence we have not followed changes in names re-

[1] I. Anisoptera. Philip. Journ. Sci. 63 (1937) 21; II. Zygoptera. Ibid. 70 (1939) 239.

cently proposed, save only in the case of *Euphæa*, which is merely a restoration of a long-used earlier name. Kirby proposed to substitute the name *Pseudophæa* because he found *Euphæa* preoccupied; and Cowley later found that *Euphæa* was not preoccupied and it is therefore restored.

INDÆSCHNA BALUGAS Needham and Gyger.

The male of this species was described in Part I of our Dragonflies of the Philippines.[2] We now have a single, very mature female from the same locality, Mount Banahao, Luzon, collected April 27, 1936, by Mr. V. J. Madrid.

Length, 82 mm; abdomen, 60; hind wing, 60.

The female is a little more uniformly blackish than the male, and a little less hairy, with more amber tinting in the membrane of the wings, and with much shorter and stouter abdomen. In our very mature specimen no trace remains of the pale stripes on the front of the thorax, and those on the sides are reduced to three indistinct spots: a round spot behind the humeral suture, and two more spots behind the third lateral suture; of the latter the upper is half the size of the lower. The abdomen shows the pale apical cross rings on abdominal segments 3 to 6, much as in the male. The wings are broader, especially the hind wings, and have a distinct brown spot covering their roots. The nodal crossveins are 28: 18–19 and 17: 22 in the fore- and hind wing, respectively, with the second and twelfth in the forewing and the second and eighth in the hind wing hypertrophied.

This species is very closely related to *Indæschna perampla* Martin, and may yet prove to be identical with it. There is agreement in size and in general coloration, but the labrum is not black but green, save for a very narrow brownish edging. Martin's figure[3] of the wings as those of *perampla* is doubtless incorrectly labelled; it does not correspond with his description. Perhaps through inadvertence it was labelled *Amphiæschna perampla* when *A. ampla* was intended; for it is on the same page with the description of *ampla*.

Our specimens show in both sexes the venational characteristics of *Indæschna:* two cell rows in the fork of the vein Rs in both wings and one row in the fork of Cu in the hind wing. The male generically agrees with Martin's figure of the male appendages of *perampla*, and the female with Fraser's figure[4] of the

[2] Philip. Journ. Sci. 63 (1937) 44, pl. 2, figs. 31, 32.

[3] Coll. Zool. de Selys Aeschninae. fascs. 19, 20 (1909) 114.

[4] Treubia 8 (1926) 476; likewise mislabelled by transposition of figures with those of *Amphiæschna ampla*.

genitalia of the female of *I. grubaueri* Forster, the type species.

DIPLACINA LISA sp. nov. Plate 1, fig. 21.

Male.—Length, 32 mm; abdomen, 22; hind wing, 26.

Teneral coloration blackish varied with yellow. Face and frons yellow except for an encircling narrow line of black in front of the ocelli, that widens at the side to include the wholly black antennæ, and then narrows again as it runs downward along the border of the eye to the mouth. Labium wholly yellow. Vertex and occiput blackish. Across the pale rear side of each eye there are three blackish horizontal bars.

Prothorax blackish above with its broad hinder lobe yellow. This lobe is erect but scarcely bilobed, and bears a marginal fringe of very long soft hairs, that are longer than the lobe is high. The synthorax is blackish in front, with a yellow band across the top from side to side, its inner half within and its outer half lying just below the crest. Lower down on each side of the front there is a broad, yellow band that is wide and angulated at its inner end next the carina and narrows laterally and runs down on the middle coxa. The sides of the synthorax are yellow with the usual black H mark of the genus (on the second and third lateral sutures) incomplete on the second suture, and wanting beneath the spiracle. The legs are blackish with only the outer side of the front femora yellow. Wings hyaline with a faint tinge of hyaline at the base. Veins brown, stigma tawny. Ante- and postnodal crossveins 13 : 8 and 10 : 8 in fore- and hind wing, respectively. Triangles free from crossveins except for one in the supertriangle of a forewing and one in the triangle of a hind wing.

Abdomen fuscous varied with yellow. The sides of segments 1, 2, and 3 are mainly yellow and there is a diffuse midlateral yellow area on segments 4 to 9 that diminishes in size to rearward. The apical dorsal margin of the first segment is sparsely fringed with long brown hairs. Appendages black. A single male specimen from Los Baños was collected January 27, 1936, and sent us by Doctor Uichanco.

This species is near to *Diplacina nana*, but differs in a number of characters. It entirely lacks the black longitudinal band that traverses the labium in that species. It lacks the lower end of the black stripe on the midlateral suture of the thorax below the spiracle. The yellow of the front of the synthorax seems to be laid on in quite a different pattern. The inner branch of the genital hamule is long and sharp.

D. lisa differs from both its nearest allies *nana* and *smaragdina* in having a crossvein in the triangle of one hind wing.

We add new figures (Plate 1, fig. 22 and 23) of the genital hamules of the male of *Diplacina bolivari* and *D. braueri*. The latter has not been figured, and Ris' figure [5] of *bolivari* does not show the thin and transparent platelike inner edge of the outer branch of the hamule.

The type is in the Cornell University collection.

DREPANOSTICTA ARIES sp. nov. Plate 1, figs. 3, 4, 8, and 9.

Male.—Abdomen, 35 mm; hind wing, 24.

Female.—Abdomen, 31 mm; hind wing, 24.

A slender blackish species, white about the mouth, with basal pale rings on the very slender abdominal segments.

Male.—Mouthparts pale, except for a narrow front border of black on the labrum and a shiny black triangular streak on the base of the mandibles externally. Anteclypeus white; the narrow postclypeus shiny black. Pedicel of antennæ pale; remainder of upper surface of head black. Occipital border slightly concave, ending in a slight rearward projecting angle on either side.

Prothorax pale, darker on front lobe, on all convex areas, and between bases of horns on hind lobe. These horns flat, outcurving like the horns of the conventional ram that appears among the signs of the zodiac. Synthorax greenish black on its front, with a very black edging on its middorsal carina. Sides brown, paler below the subalar carina, and about the base of the legs. Legs pale with a touch of brown above the knees, and with reddish spines. Wings hyaline with brown veins and stigma. Postnodals, forewing 16 or 17, hind wing, 15 or 16. Stigma rhomboidal, covering a single cell. Middle fork at subnodus: vein Rs arising half a costal cell beyond it.

Abdomen blackish, pale on basal segments, darkest on subterminal segments. Pale subbasal rings on segments 3 to 6 widened below, narrowed toward the middorsal line. The short segment 10 paler, with only its carinæ interruptedly brown. Appendages pale brown. Superiors not longer than inferiors: both swollen at base and forcipate at tips, angulated internally but without teeth (Plate 1, fig. 9).

Female.—Colored like the male, hind lobe of prothorax slightly produced in a trilobate margin. The short triangular-pyramidal caudal appendages yellow, hardly as long as segment 10.

[5] Coll. Zool. Libell. fasc. 9 (1909) 98.

Smaller than *D. taurus* and with shorter stigma and male superior appendages lacking inferior tooth.

Holotype, male, Mindanao, Mount Apo, Galog River, altitude 6,000 feet, September 4, C. S. Clagg. Allotype, female, same data. Both in the Museum of Comparative Zoology. Paratypes in the Museum of Comparative Zoology and the Cornell University Collection.

DREPANOSTICTA TAURUS sp. nov. Plate 1, figs. 1, 2, 5, 6, 7, and 10.

Male.—Abdomen, 47 mm; hind wing, 25.

Female.—Abdomen, 37 mm; hind wing, 26.

This is a blackish species with yellowish mouth parts, and a very slender abdomen.

Male.—Labrum reddish yellow, fringed with stiff bristles; anteclypeus yellow; postclypeus shiny black; antennæ black with segment 2 tawny. Top of head wholly black. The concave occipital border ending each side in a sharply projecting angle.

Prothorax blackish, paler toward front, its hind lobe bearing a pair of long, slender, cylindric, tapering horns that are almost as long as the dorsum is wide. Synthorax deep greenish black in front, brownish black on sides, black between leg bases, yellowish to rearward beneath. Legs pale, darker along dorsal carinæ of femora, and especially near knees. Leg spines all pale; claws reddish. Wings hyaline, membrane very faintly tinged. Postnodals 16 and 15 in fore- and hind wings, respectively. Stigma rhomboidal, one and one-half as long as wide, surmounting a little more than a cell. Middle fork at or very slightly beyond abdomen; vein Rs arising less than half a costal cell beyond it.

Abdomen very elongate, blackish throughout its length, with only segment 10 and the appendages a little paler, and with yellow subbasal rings on segments 3 to 6. Superior appendages a trifle longer than inferiors, both wide and angulate in the basal third and forcipate beyond; near midway superiors with a sharp internal tooth that inclines downward (Plate 1, fig. 5).

The female is similar to the male in coloration. The hind lobe of the prothorax ends laterally on each side in a small, rather sharply pointed and distinctly recurved tooth. The appendages of segment 10 are yellowish.

The species seems to be allied to *D. bicornuta* of de Selys from New Guinea, but the horns of the prothorax at least do not fit the description of that species. Similar to *D. aries* in general coloration, but very different by its straight bovine prothoracic horns.

Holotype, male, Mindanao, Davao Province. La Lun River, July 4, *C. S. Clagg*. Allotype, female, same locality and collector, May 3. Both in the Museum of Comparative Zoology.

PRIONOCNEMIS ATRIPES sp. nov. Plate 1, figs. 11, 13, and 14.

Male.—Abdomen, 44 mm; hind wing, 29.

Female.—Abdomen, 42 mm; hind wing, 31.

This is a slender, black species with a white bar above the mouth and whitish membranes about the wing roots. Entire dorsum black. Face black except for the anteclypeus and basal third of the labrum which are white. Front third of labrum and top of postclypeus metallic black, tinged with greenish or bluish in reflected light.

Thorax black, with only the thin membrane about the wing roots whitish; sides hairless. Midventral prominence of prothorax black on a paler ground. Legs black. Wings hyaline, with black veins and stigma, membrane highly tridescent. Postnodal crossveins about nineteen. The lozenge-shaped stigma generally covering a single cell. Lines of crossveins in field behind stigma strongly concave to outer side. Arculus at or very close to second antenodal crossvein.

Abdomen including appendages black dorsally and externally, paler beneath. Appendages of male paler within, huge inferior tooth of superiors black. Length of abdominal segments 6 to 10 about as 10 : 8 : 4 : 2 : 1.5, superior appendages as long as segment 10, slightly divaricate, parallel-sided at base and with a long bevel to outer apex, bevelled portion in lateral view in almost direct line with outer side of large inferior tooth.

Surmounted by this tooth is a large rounded hump on base of inferior appendage. Lower outer point of that appendage extended laterally.

Female very similar to male but paler. Hind lobe of prothorax in female with a W-shaped median notch.

Type, male, Mindanao, Mount Apo, Mainit River, altitude 6,500 feet, October 27. Allotype, female, same locality, August 14. Both in the Museum of Comparative Zoology. Paratypes in the Museum of Comparative Zoology and in the Cornell University Entomological Collection.

In our key to the species of *Prionocnemis* [6] this species will run out with *atropurpurea*, except that in *atripes* the legs are wholly black.

[6] Philip. Journ. Sci. 70 (1939) 270.

PRIONOCNEMIS TENDIPES sp. nov. Plate 1, figs. 12, 15, and 16.

Male.—Abdomen, 48 mm; hind wing, 32.

Female.—Abdomen, 43 mm; hind wing, 32.

This is a large, brownish, red-legged species with rather broad wings and somewhat trapezoidal stigma. The general color of the body is brown, suffused with blackish on the front of the thorax and tending toward red on the middle abdominal segments. Face brown; anteclypeus paler, postclypeus and labrum becoming shiny black with age. Top of head brown, blackish around ocelli and on hind occipital margin.

Top of thorax brown with the carina and sutures narrowly black. Paler underneath. An isolated line of six to twelve long, thin bristles parallel to and close behind humeral suture. A shiny black prominence at upper end of first and third lateral sutures, another at lateral articulation of thorax and abdomen. Legs beyond brownish coxæ bright reddish, including spines and claws. Wings subhyaline, with 20 to 22 postnodal crossveins. Arculus at or very slightly beyond second antenodal crossvein. Stigma brown, trapezoidal, slightly longer at rear than along front side.

Abdomen brown, darkening toward ends, washed with blackish upon all joints of segments and with reddish along dorsum of long middle segments. Segments 6 to 10 of male in length as 10 : 7 : 4.5 : 2 : 1, superior appendages 2. Appendages of the male reddish with black tips: superiors elongate-triangular with apices slightly divergent; inferior tooth basal and rather small.

The female is paler, but similarly colored. Hind lobe of thorax widely notched.

Type, male, Mindanao, Mount Apo, Galog River, September 6 (*C. S. Clagg*). Allotype, female, same locality, September 4. Both in the Museum of Comparative Zoology. Paratypes in the Museum of Comparative Zoology and in the Cornell University Entomological Collection.

In our key to the species of *Priocnemis* [7] this species will run out with *rubripes*, from which it will be readily distinguished by its larger size as well as by differences shown in our figures.

PRIONOCNEMIS IGNEA Brauer. Plate 1, figs. 17 and 18.

A number of specimens collected by Mr. C. S. Clagg on Mount Apo, Mindanao, agree very well with Brauer's original descrip-

[7] Loc. cit.

tion draw from Luzon specimens, and with the single female from the Agricultural College reported on and figured by us in Part II of our monograph.[8] They are very similar in superficial appearance to *P. tendipes* but distinctly smaller. Both sexes are represented among them so we now add figures of the male appendages (Plate 1, figs. 17 and 18).

PERICNEMIS INCALLIDA Needham and Gyger.

The male has been described in The Philippine Journal of Science.[9] A female has since been found among the material sent by Doctor Uichanco bearing the data "7 III '36. J. T. Hernandez." It may be described as follows:

Abdomen, 50 mm; hind wing, 36.

Much paler than the male, being brownish olive where the male is black, and light green where the male is dark metallic green. The top of the head is dark green and the face is similar in pattern to the male except that the black on the labrum is restricted to a large median spot and a marginal streak at each side.

The thorax is nearly concolorous, merely paler below. The abdomen is brownish black above and yellowish beneath, with the yellow spreading upward to cover most of the dorsum of segment 9 and most of the sides of segment 8. The ovipositor is yellow with black edgings. Segment 10 and the very short appendages are black.

PERICNEMIS LESTOIDES Brauer. Plate 1, fig. 24.

The male of this species has been redescribed and figured by us in the Philippine Journal of Science, [10] with full bibliography. A female has since been received from Doctor Uichanco labelled "Mt. Maquiling, 8 VII, '37." It may be described as follows:

Abdomen, 45 mm; hind wing, 29.

Agrees with the male in having the head broadly black above but the coloration lighter everywhere else. The postclypeus is not wholly black but bears a transverse row of three yellow spots. The pale area at each side of the face extends up to and around the roots of the antennæ. The labrum is mainly yellow with the black restricted to its basal hinge line, and three short streaks project forward therefrom, one median and the others marginal.

Thorax olive-brown with faint coppery reflections in front. A black hair line tops the edge of the carina. Under parts pale.

[8] Ibid., p. 275. [9] Ibid., p. 291. [10] Ibid., p. 297.

Legs very pale with black spines and blackish joints to the segments and a black line on the foretibia externally.

Abdomen black above and pale beneath, becoming yellowish on the sides toward the end. From the base of the very long segment 7 onward the dorsum becomes obscurely reddish, including stylets and ovipositor.

TEINOBASIS RANEE sp. nov. Plate 1, figs. 10 and 20.

Male.—Abdomen, 52 mm; hind wing, 32.

Female.—Abdomen, 51 mm; hind wing, 33.

Closely allied to *T. glauca* Brauer, of which we describe first the female, to facilitate direct comparison with the male, hitherto unknown.

Female.—Face pale yellowish brown up to crossridge of frons, with a median impressed black spot on base of labrum and black edgings at labroclypeal suture. Anteclypeus pale. Postclypeus darker, with two black outer edges and a pair of submarginal, impressed, oval, obscure, blackish spots. Top of head wholly black. Antennæ pale brown with a black streak up inner side of both segments of pedicel. Margin of occiput and rear of eyes pale.

Prothorax brown with brown bands across its front and rear lobes, and a diffuse black area above each leg base, also an ill-defined middorsal stripe of black. Synthorax with a black middorsal stripe narrowed downward to the black collar, and widened at its upper end where it is forked and spread out beneath the antealar crest. Crest black with a yellow spot each side at front. Subalar carina pale with black touches where it joins the second and third lateral sutures. Sides otherwise pale brown, becoming yellowish below. Legs pale with blackish spines and blackish markings at all articulations and black along dorsal side of all femora. Hind tibiæ with five spines in each row.

Wings hyaline, with a brown stigma that is bordered by heavy veins, inside which is an encircling line of yellow. Postnodals 18 and 16 in fore- and hind wing, respectively. Wings stalked to the level of the arculus which is slightly beyond the second antenodal crossvein. Middle fork a little before the subnodus (in one male forewing at the subnodus and there fused with base of vein Rs); vein Rs variable at origin but usually slightly beyond subnodus. Vein M_2 arising usually at ninth postnodal in forewing and seventh in hind wing, not constant. Stigma

trapezoidal, about as long as wide, slightly convex externally on all sides but mostly so on outer side.

Abdomen blackish on dorsum from end to end, paler on sides and beneath with paler color spreading upward at joinings of segments, but not meeting above to form rings: sides of segment 8 broadly yellowish. Caudal appendages conic, shorter than segment 10. Sheath of ovipositor and palp brown with yellowish tip.

Male.—Old and pruinose, blackish pulverulent over top of head and on all of face except genæ; also over entire dorsum of thorax and halfway down sides of synthorax. Black of dorsal surface of legs extending outward on tibiæ and tarsi to base of yellow claws. The slenderer abdomen colored as in female except at posterior end where segment 8 is wholly black above and on sides, as also is segment 9, while segment 10 is yellow at sides and has a middorsal yellow triangle in the black of the dorsum just before its apical notch. Appendages yellow, brown-tipped, blunt superiors with a terminal tuft of yellow hair.

The largest species of the genus, too large for comparison with any of the numerous described species except *T. glauca* Brauer, from which it seems to differ in lacking the bluish white of the face and the dorsal pattern of abdominal segment 8, and in having the ovipositor serrulate and not hairy along its lower margin.

Holotype, male, Mindanao, Davao Province, La Lun Mountains, May 3 (*C. S. Clagg*). Allotype, female, Mindanao, Mount Apo, Paraka River, November 10 (*C. S. Clagg*). Both in the Museum of Comparative Zoology.

ILLUSTRATION

Plate 1

Fig. 1. *Drepanosticta taurus* sp. nov.; dorsal view of anal appendages of male.

2. *Drepanosticta taurus* sp. nov.; lateral view of anal appendages of male.
3. *Drepanosticta aries* sp. nov.; lateral view of anal appendages of male.
4. *Drepanosticta aries* sp. nov.; dorsal view of anal appendages of male.
5. *Drepanosticta taurus* sp. nov.; diagonal interior view of superior anal appendage of male.
6. *Drepanosticta taurus* sp. nov.; front view of prothorax of female.
7. *Drepanosticta taurus* sp. nov.; front view of prothorax of male.
8. *Drepanosticta aries* sp. nov.; front view of prothorax of male.
9. *Drepanosticta aries* sp. nov.; diagonal interior view of superior anal appendage of male.
10. *Drepanosticta taurus* sp. nov.; lateral view of tip of abdomen of female.
11. *Prionocnemis atripes* sp. nov.; front view of prothorax of female.
12. *Prionocnemis tendipes* sp. nov.; front view of prothorax of female.
13. *Prionocnemis atripes* sp. nov.; dorsal view of anal appendages of male.
14. *Prionocnemis atripes* sp. nov.; lateral view of anal appendages of male.
15. *Prionocnemis tendipes* sp. nov.; lateral view of anal appendages of male.
16. *Prionocnemis tendipes* sp. nov.; dorsal view of anal appendages of male.
17. *Prionocnemis ignea* Brauer; dorsal view of anal appendages of male.
18. *Prionocnemis ignea* Brauer; lateral view of anal appendages of male.
19. *Teinobasis ranee* sp. nov.; lateral view of anal appendages of male.
20. *Teinobasis ranee* sp. nov.; dorsal view of anal appendages of male.
21. *Diplacina lisa* sp. nov.; lateral view of hamules of male.
22. *Diplacina bolivari* Selys; lateral view of hamules of male.
23. *Diplacina braueri* Selys; lateral view of hamules of male.
24. *Pericnemis lestoides* Brauer; lateral view of tip of abdomen of female.

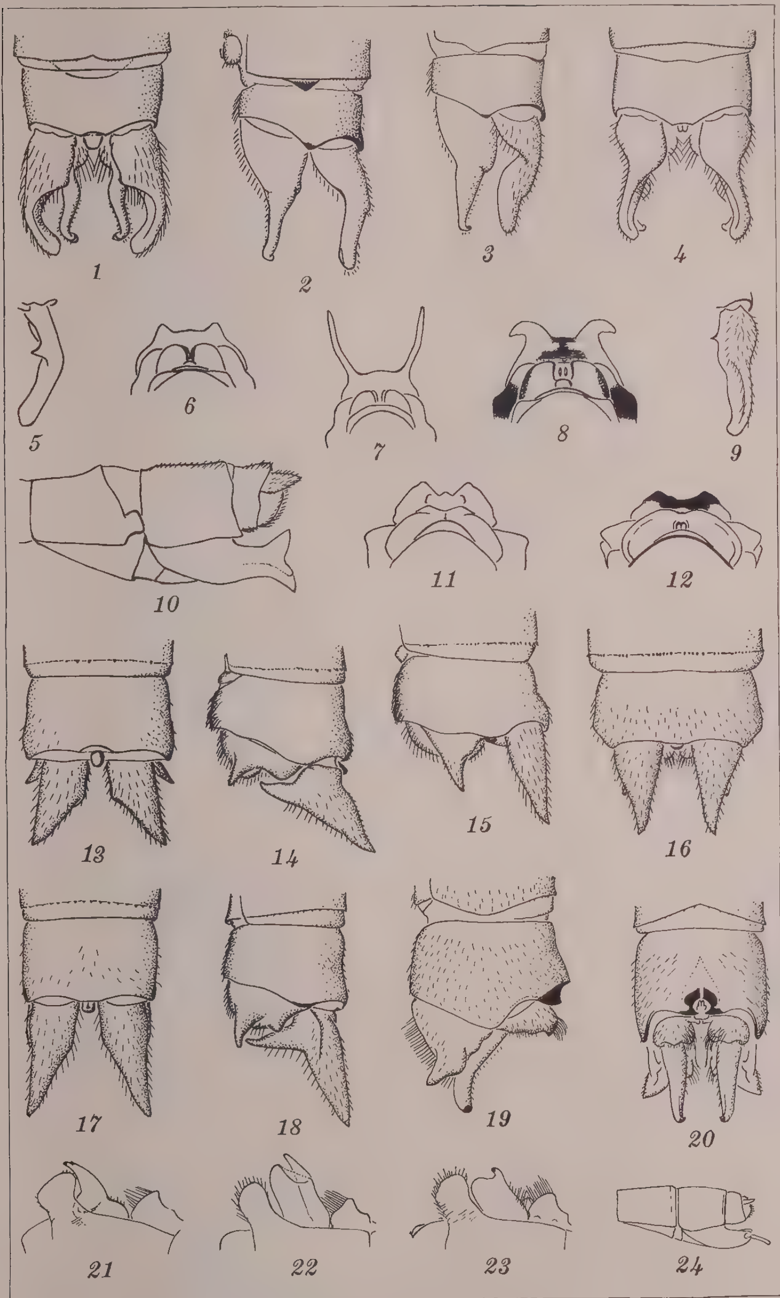


PLATE 1.

HOLTTUMIA, GENUS NOVUM

By Edwin Bingham Copeland
Of the University of California, Berkeley

ONE PLATE

Genus Dipteridi affine, fronde minuta orbiculare haud dichotoma carnosa distinctum; rhizomate repente setis rigidis nigris vestito; costa media in lamina deliquescente, venis flabellato-dichotomis, hic illus anastomosantibus venulis inclusis nullis; soris orbicularibus, nudis, intramarginalibus, ad furcas venularum, sporangiis (ut videtur) sessilibus.

Typus in Herb. Singapore, l. G. F. Hose, Mount Linga, Sarawak, 1889. R. E. Holttumio, Directori illustrissimo Horti Singaporensis, dedicatum.

HOLTTUMIA FLABELLIFOLIUM (Baker) Copeland comb nov. Plate 1.

Polypodium flabellifolium BAKER, Syn. Fil. (1867) 322.
Polypodium holophyllum BAKER, Journ. Bot. (1879) 43.

In his first description Baker remarked on this species as a remarkable plant, and Diels, in Natürliche Pflanzenfamilien, characterized it as completely isolated. That would be so, indeed, in *Polypodium,* but the affinity to *Dipteris* seems to me to be unmistakable. The fronds in hand are hardly over 1 cm in diameter, on filiform stipes about 3 cm long. In the herbarium the laminæ are rugose, evidently due to the collapse of the once fleshy mesophyll. The margin, instead of being thickened as Baker described it, is cartilaginous and firm, but thinner than the rest of the frond. As a protection against collapse, the epidermal cells have the lateral walls reinforced by projections into the lumen. These project from the back of the guard cell into the parent cell, protecting the stoma against lateral compression as in *Medeola* [1]; the stomata of this mechanical type in ferns were described by the present author in 1907.[2]

Besides the generic type there is in the Singapore Herbarium another collection, evidently also by Bishop Hose, dated 1887. Both are scanty and old, with few sporangia remaining. In view of the particular interest attached to any relative of *Dipteris,* material for a more complete study is much desired.

[1] Annals of Botany 16 (1902) 333.
[2] Philip. Journ. Sci. § C 2 (1907) 41.

ILLUSTRATION

PLATE 1. *Holttumia flabellifolium* (Baker) Copeland sp. nov.; Fig. *1*, habit; *2*, frond, $\times$ 4.

PLATE 1.

MANILA COPAL OXIDATION AND GEL FORMATION

By Gloria D. Manalo and Augustus P. West
Of the Bureau of Science, Manila

FOUR TEXT FIGURES

One of the important minor forest products of the Philippines is Manila copal, which is used principally in making high-grade varnishes. In previous reports [1] methods were given for analyzing and refining this resin. Some lots contained more than 40 per cent of material insoluble in alcohol. Stocks containing much insoluble matter are considered low-grade and are not purchased for export by local dealers.

The insoluble matter usually consists of gelatinous material together with foreign impurities. Oxidation of the copal apparently precedes the formation of the gel. Results on copal oxidation as related to gel formation are recorded in this paper.

When soft Manila copal (1) is analyzed it is separated into its usual constituents which are insoluble matter (2); terpenes (3); resenes (4); and resin acids (5), as shown in text fig. 1.

In general, soft Manila copal was found to consist mostly of resin acids (5). As shown by the data (text fig. 2) these acids were composed of a mixture of free resin acids and a saponifiable substance. The ester number (41) indicates that the saponifiable substance is a lactone.[2]

We have examined many samples of copal and they all gave an ester number which is the difference between the saponification and acid numbers. The ester number of the copal, or of the resin acids obtained from it, gives an idea of the amount of lactone present.

The resin acids (5) were separated (text fig. 2) into their constituents which were the resin acids (6) and (7). The separation was not complete, as resin acid (6) was contaminated

[1] Tanchico, S. S., and A. P. West, Philip. Journ. Sci. **73** (1940) 259–283; 285–291.

[2] Lewkowitsch, J., Journ. Soc. Chem. Ind. **15** (1896) 15.
Richmond, G. F., Philip. Journ. Sci. § A **5** (1910) 191.
Allen's Commercial Organic Analysis 4 (1925) 277.

with some acid (7), as shown by the ester number (16.16). These acids had very different constants. The saponification number of acid (6) was almost double that of acid (7).

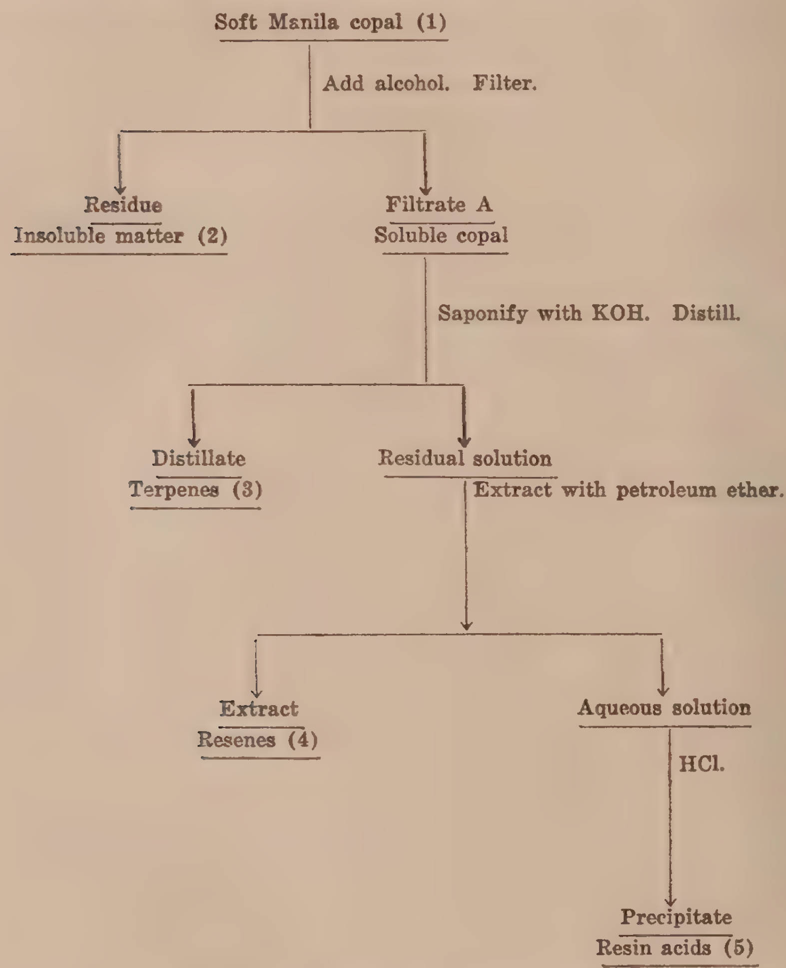


FIG. 1. Analysis of soft Manila copal.

By dissolving resin acid (6) in alcohol and neutralizing the solution, a second precipitation of the sticky residue may be obtained. When the filtrate from this residue is again boiled (reflux) with potassium hydroxide, the excess alcohol removed by distilling, and the solution diluted with water and then acidified

Resin acids (5)

Sap. No.	164
Acid No.	123
Ester No.	41

Dissolve in alcohol.
Neutralize with KOH.
Filter.

Solution
K salt resin acid (6)
with some K salt resin acid (7)

Reflux with KOH.
Acidify with HCl.
Filter.

Resin acid (6)

Sap. No.	212.40
Acid No.	196.24
Ester No.	16.16

Sticky residue
K salt resin acid (7)
and lactone

Saponify with KOH.
Acidify with HCl.
Filter.

Resin acid (7)

Sap. No.	119.67
Acid No.	78.35
Ester No.	41.32

FIG. 2. Separation of the mixture, resin acids (5).

with hydrochloric acid, there is obtained a second precipitation of resin acid (6). By this procedure more of the resin acid (7) is removed from resin acid (6). The ester number of acid (6) is thus considerably reduced.

The sticky residue obtained by neutralizing an alcoholic solution of resin acids (5) consists of the potassium salt of resin acid (7) and a lactone (text fig. 2). When the sticky residue is treated with water the potassium salt dissolves, leaving the lactone. The lactone, when dried at 50° C., was found to be slightly soluble in methyl alcohol and acetone but practically insoluble in the other common organic solvents.

The moist lactone was saponified with alcoholic potassium hydroxide. The reaction product was distilled to remove excess alcohol. It was then treated with water and acidified with hydrochloric acid which precipitated resin acid (7). The constants of this acid are as follows:

Resin Acid (7) from lactone alone.

Sap. No.	120.68
Acid No.	84.22
Ester No.	36.46

These constants are very nearly the same as those of the resin acid (7) in text fig. 2. Similar results were obtained in a previous investigation.[3]

Resin acid (7) obtained from the lactone alone gave an ester number of 36.46. The acid (7) in text fig. 2 had an ester number of 41.32. In each case these ester numbers show that a lactone has been reformed to a considerable extent from resin acid (7) when the acid is liberated from its potassium salt.

Lewkowitsch[4] investigated the fatty acids in wool wax and found that they gave an ester number (15.79). According to him the ester number indicates the presence of a lactone in the fatty acids. The results of his researches on the lactone were similar to those obtained by us.

INSOLUBLE MATTER IN SOFT MANILA COPAL

Treatment of soft Manila copal with hot alcohol dissolves the alcohol-soluble part (text fig. 1). Insoluble matter (2), if present, usually consists of a grayish, gelatinous mass that contains some foreign matter, such as dirt, and perhaps pieces of leaves and twigs. When the mixture is allowed to stand overnight the alcohol-insoluble constituents settle out and are removed by filtering. When the insoluble matter is heated to a temperature of 50 to 60° C. for about a week, the gel that is contained in it slowly undergoes various changes, as indicated below:

Gelatinous insoluble matter

↓

Viscous, elastic material

↓

Amorphous solid

↓

Impure brittle resin

The insoluble matter is first converted into a viscous, elastic material that gradually changes to an amorphous solid which finally becomes an impure brittle resin. With some samples this transformation may be hastened by simply boiling the amorphous

[3] Tanchico, S. S., and A. P. West, Philip. Journ. Sci. 73 (1940) 259–283.

[4] Journ. Soc. Chem. Ind. 15 (1896) 15.

solid with water or steaming for about three hours, after which the brittle resin is drained off and dried at 50 to 60° C.

The gelatinous part of the insoluble matter is thus converted into a brittle copal resin, soluble in alcohol. It would appear that the gel is very closely related to the genuine copal and is probably a modified form.

With some samples the insoluble matter contained no gelatinous material and consisted entirely of foreign matter (dirt, twigs, leaves, and the like). Such copal was not aged long enough to accumulate gel and no particular precautions were taken to keep the exudation clean.

Richmond [5] examined some surface copal. He also found it to be incompletely soluble in absolute alcohol, leaving a grayish, gelatinous, neutral residue which dried to a brittle resin.

A composite sample of the insoluble matter (2) (text fig. 1), obtained from several lumps of copal, was analyzed as indicated in text fig. 3.

Analysis of the soluble copal separated from the impure brittle resin showed that it contained very small amounts of terpenes and resenes and was composed almost entirely of resin acids (10). These acids consisted of a mixture of free resin acids and a saponifiable substance (lactone) indicated by the ester number (31.55). These products were separated (text fig. 3) into resin acids (11) and (12), which had different constants.

The separation of resin acids (11) and (12) is generally not complete. Acid (11) usually has an ester number due to contamination from acid (12). These various acids were given these particular numbers because, in a previous investigation,[6] nine other products were isolated from the copal before these acids were obtained.

The formation of the insoluble gel in Manila copal may, perhaps, be explained in accordance with the outline in text fig. 4.

White, soft copal (text fig. 4) that is soluble in alcohol consists of terpenes, resenes, and resin acids (6) and (7). This kind of resin, obtained as a fresh or very recent exudation from the copal tree, contains no insoluble gelatinous material. As the copal ages it gradually becomes hard and darker in color. The hardening of the surface copal is accompanied by partial evaporation of volatile constituents (terpenes and moisture) and oxidation of the resin acid (7) which, as shown later, is the prin-

[5] Philip. Journ. Sci. § A 5 (1910) 183.

[6] Tanchico, S. S., and A. P. West, Philip. Journ. Sci. 73 (1940) 259–283.

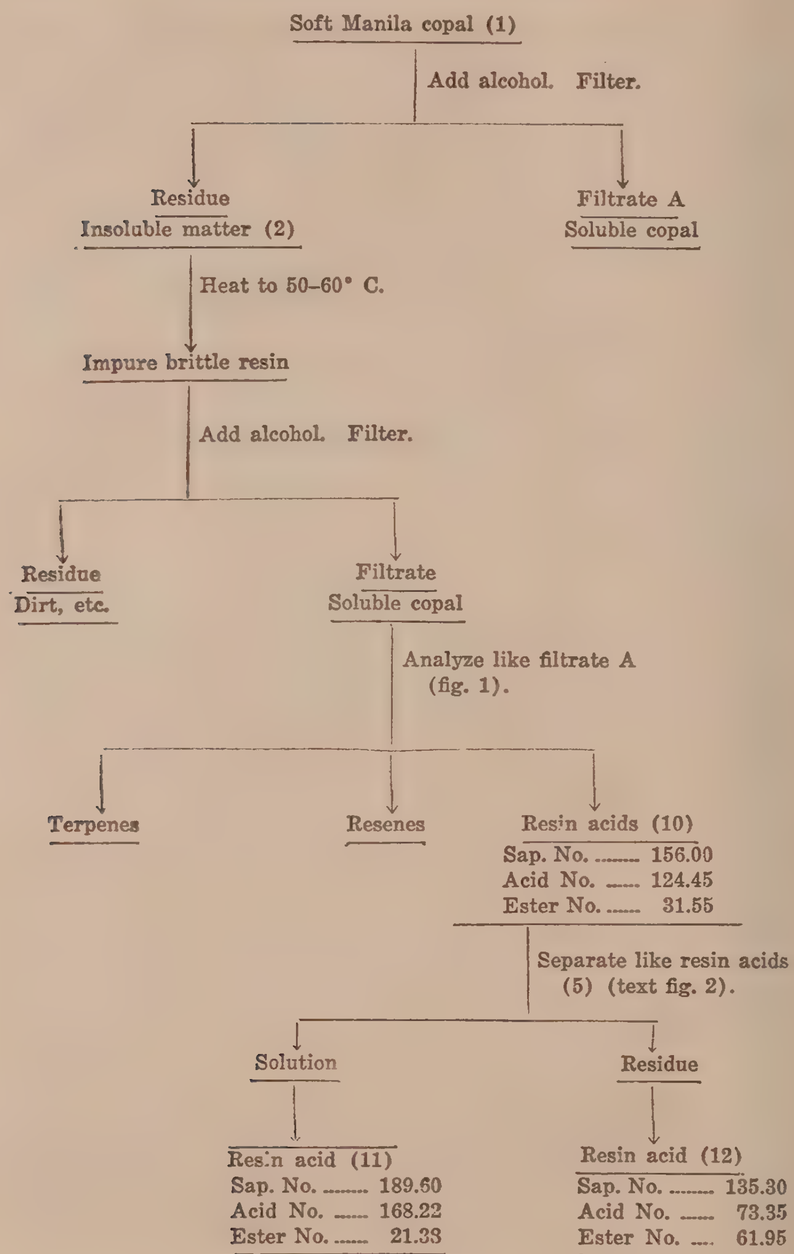


FIG. 3. Analysis of insoluble matter in soft Manila copal.

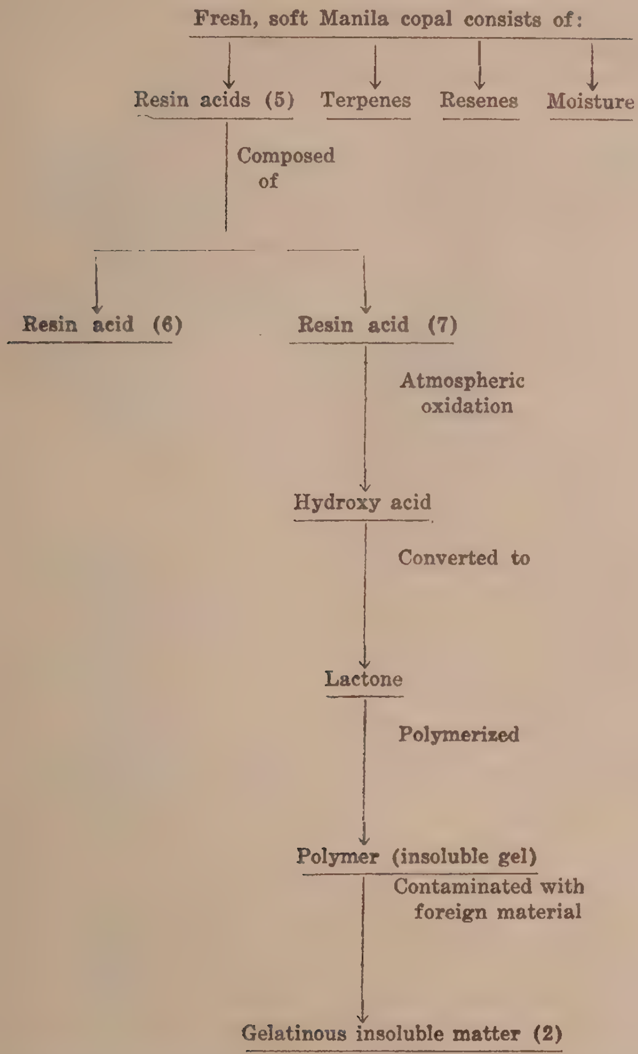


FIG. 4. Formation of gelatinous insoluble matter in fresh, soft Manila copal.

Note: As shown later (Table 4) resin acid (6) is not affected by atmospheric oxidation.

cipal constituent affected. The hydroxy acid, thus formed, is gradually converted to a lactone which tends to act as an antioxidant and hinder further oxidation of the copal.

The presence of the lactone (text fig. 2) is indicated by the high ester number (41.32) of the resin acid (7).

Richmond[7] noted the tendency of copal resin acids to form lactones.

As the copal grows older and larger, more of the lactone is produced. It appears that the lactone is slowly converted to complex bodies of high molecular weight. These polymers constitute the insoluble gel that accumulates principally in the surface copal as it ages on the tree. The gel probably serves as a protective coating for the interior copal. It is likely to be contaminated with foreign material (dirt and the like), thus constituting the usual insoluble matter (2) that is separated in the analysis of copal (text fig. 1). When the insoluble matter is heated the gel in it depolymerizes and is converted into a brittle copal resin (text fig. 3), soluble in alcohol.

Ellis[8] discusses the conversion of lactones into polymers as follows:

> Lactone formation is of importance in the chemistry of resins, an example of a naturally occurring product of this type being shellac. Lactones, or inner esters, are obtained by the elimination of water between a hydroxyl group and a carboxyl group. ....
>
> Many lactones, particularly six-membered cyclic esters, are known to polymerize with ease, and depolymerize (reversible polymerization) on heating. ....
>
> It seems probable that the first step in the polymerization of cyclic esters (lactones) involves the intervention of a trace of the corresponding hydroxy acid. This reacts with the lactone to give the dimeric acid. The latter in turn yields a trimeric acid, and reaction continues until all the lactone is exhausted or the chains become too long for further reaction.

Concerning the formation and polymerization of lactones of the fatty acids Lewkowitsch[9] states:

> Neutralisation and saponification values of fatty acids should be identical. In case, however, the fatty acids contain such substances as lactones, or anhydrides of the fatty acids, which do not combine with aqueous alkali in the cold (and are only hydrolysed on boiling with alcoholic potash), then the saponification value of the fatty acids will be higher than the neutralisation number. ....
>
> Hydroxylated fatty acids especially are likely to suffer dehydration with the formation of inner anhydrides. Thus the fatty acids of castor oil readily form inner anhydrides (polymerisation products); indeed it has been shown that the fatty acids of castor oil become "polymerised" even at the

[7] Philip. Journ. Sci. § A 5 (1910) 191.

[8] The Chemistry of Synthetic Resins 2 (1935) 1000.

[9] Chemical Technology and Analysis of Oils, Fats and Waxes 1 (1921) 528 and 531.

ordinary temperature on prolonged keeping, forming polyricinoleic acids. .... In the case of such polymerised ricinoleic acids the difference is considerable between the saponification and the neutralisation values.

EXPERIMENTAL PROCEDURE

The Manila copal used in this investigation was collected by forest rangers and kindly presented to us by Director Florencio Tamesis of the Philippine Bureau of Forestry. It was the soft variety, like the samples used in previous experiments [10] carried out in this laboratory.

Since oxidation is apparently an important reaction in the ageing and weathering of Manila copal, experiments were carried out to determine the exact effects of oxidizing this resin.

High-grade copal, containing less than one per cent of insoluble matter, was powdered very finely and placed in a tube about 1 meter long and 2 centimeters in diameter. Some cotton was inserted into each end of the tube to keep the copal intact. The tube was connected to a Drechsel wash bottle, containing a small amount of water, and this in turn was joined to a vacuum pump. The rate at which the air was drawn through the copal was indicated by the passage of the air through the liquid in the wash bottle.

The air was passed continuously through the copal, at room temperature, for 30 days and nights. The copal was analyzed and the constants determined both before and after oxidation. The methods [11] for obtaining these data were the same as those reported in a previous communication. The alcohol used as solvent for the copal was aldehyde-free, absolute alcohol.[12] In the determination of the acetyl number we followed the procedure recommended by Gardner.[13] For accurate comparison all the results (Table 1) were calculated on a moisture-free basis.

As shown by the data (Table 1) oxidation of the copal gave a marked increase in the saponification, ester, and acetyl numbers. During the oxidation there was an increase in the amount of hydroxy acids in the copal as indicated by the rise in acetyl number. A rise in the ester number indicated that the amount of lactones also increased. The lactones are formed from the hydroxy acids. As the hydroxy acids increase there is likely to be an increase in the amount of lactones.

[10] Tanchico, S. S., and A. P. West, Philip. Journ. Sci. 73 (1940) 259–283.
[11] Ibid.
[12] Dunlap, F. L., Journ. Am. Chem. Soc. 28 (1906) 397.
[13] Institute of Paint and Varnish Research. Washington (1937) 848.

TABLE 1.—*Oxidation of soft Manila copal.*

Experiments.	Copal.		Difference.
	Before oxidation.	After oxidation.	
Constants:			
Saponification No.	158.61	200.52	+41.91
Acid No.	103.62	110.57	+ 7.31
Ester No.	55.35	89.95	+34.60
Acetyl No.	103.47	141.66	+38.19
Analysis:			
Insoluble matter	0.50	1.22	+ 0.72
Terpenes	12.29	10.76	— 1.53
Resenes	5.01	4.41	— 0.60
Resin acids	82.20	83.61	+ 1.41
Total	100.00	100.00	

NOTES.—The powdered copal (sample No. 25) was oxidized continuously for 30 days and nights by passing through it air not previously dried. Sample 25 was thus converted to sample 26.

Before oxidation the copal had a melting point of 120° C., and contained 2.13 per cent moisture as determined by difference. After oxidation the moisture content was 8.55 per cent.

For accurate comparison the results above were calculated on a moisture-free basis.

Analysis of the copal showed that during the oxidation a small amount of the terpenes was volatilized, but there was very little change in the resene content of the copal. However, the amount of resin acids increased slightly.

The insoluble gel (polymer) is probably formed by the polymerization of lactones. As the amount of lactones increases there should be some increase in the amount of gel (polymer). Our results showed that the copal was oxidized but not to any considerable extent. The insoluble gel increased only 0.72 per cent. Apparently the lactone tends to act as an antioxidant which inhibits the oxidation of the copal. It would seem that when the copal is oxidized for 30 days the gel stage is just about reached. Production of any considerable amount of polymer probably requires a much longer period of oxidation than that employed in our experiment. Copal samples that show a high percentage of insoluble gel are probably obtained from exudations that have been exposed on the copal tree for quite a long time.

Brooks[14] believed that the atmospheric oxidation of Manila copal is accompanied by the formation of organic peroxides. He also oxidized powdered copal by allowing it to remain ex-

[14] Philip. Journ. Sci. § A 5 (1910) 225.

posed to the air for four months. The saponification number was 157 before oxidation and 182 after oxidation, thus giving an increase of 25. Brooks states that this increase points to the rearrangement of peroxides to lactones, but he did not isolate such compounds. However, he did call attention to the possibility that the oxidized copal may contain hydroxy acids which form lactones.

The air used in our oxidation experiment (Table 1) was not dried; it was just the ordinary moist laboratory air. A similar oxidation experiment was carried out with dried air. The air was well dried by passing it through sulfuric acid, calcium chloride, and soda lime. The constants of the copal after oxidizing for 30 days and nights with both moist and dried air are given in Table 2.

TABLE 2.—*Oxidation of copal with moist and dried air.*

Constants.	Moist air.	Dried air.
Saponification No.	200.52	193.80
Acid No.	110.57	111.49
Ester No.	89.95	82.31

There was a little more oxidation with the moist air since it gave saponification and ester numbers somewhat greater than the dried air.

Further experiments were made to determine what effect, if any, the terpenes or resenes have on the oxidation of copal. The resin acids (5) were separated from the copal in accordance with the outline in text fig. 1. The acids, thus free of terpenes and resenes, were powdered and exposed to atmospheric oxidation in the same manner as the copal. The results are recorded in Table 3.

TABLE 3.—*Oxidation of resin acids (5) from Manila copal.*

Constants.	Before oxidation.	After oxidation.				
		1st to 11th day.	Increase in 11 days.	11th to 33rd day.	Increase in 22 days.	Total increase in 33 days.
Saponification No.	166.91	174.14	7.23	177.58	3.44	10.67
Acid No.	134.32	136.07	1.75	137.43	1.36	3.11
Ester No.	32.59	38.07	5.48	40.15	2.08	7.56
Acetyl No.	100.53					9.12

NOTE.—The resin acids (5), separated from Manila copal (sample 27), were oxidized for 33 days and nights. The procedure was the same as in the oxidation of the copal.

The acetyl number of the acids after final oxidation was 109.65.

The oxidation was carried out in two periods—one period of 11 days followed immediately by a second period of 22 days. Samples were taken after each period and the constants determined.

Comparison of the data given in Tables 1 and 3 shows that the resin acids (5) (text fig. 1), when separated from Manila copal and free of terpenes and resenes, are oxidized less readily than the copal itself. After oxidation the saponification and ester numbers for the acids were much less than for the copal. Evidently either the terpenes, the resenes, or both, have a tendency to promote oxidation of the copal.

During the first period (11 days) that the free resin acids were oxidized, the increase in the saponification and ester numbers was more than double the corresponding increase in the following period (22 days). Continuation of the oxidation gave a decrease in the rate of oxidation.

Resin acids (5), obtained from Manila copal, consist of two acids, (6) and (7). These individual acids were again separated in accordance with the outline in text fig. 2. In this case the separation was not very complete as the acid (6) had an ester number of 20.22, showing that it contained some acid (7). A portion of acid (6) was purified by neutralizing it and removing the sticky part. This refined product then had an ester number of only 2.66. Oxidation data on acid (6), before and after refining, and on acid (7) are given in Table 4. These samples were subjected to continuous atmospheric oxidation for eleven days and nights in the same manner as that employed for resin acids (5), Table 3.

TABLE 4.—*Oxidation of resin acids (6) and (7) from Manila copal.*

Resins acids.	Constants.	Before oxidation.	After oxidation.	Difference.
Acid (6) (small ester No.)	Saponification No.	211.83	211.72	—0.11
	Acid No.	209.17	209.48	+0.31
	Ester No.	2.66	2.24	—0.42
Acid (6) with some acid (7)	Saponification No.	211.81	215.07	+3.26
	Acid No.	191.59	192.45	+0.86
	Ester No.	20.22	22.62	+2.40
Acid (7) (large ester No.)	Saponification No.	133.86	139.71	+5.85
	Acid No.	93.14	92.58	—0.56
	Ester No.	40.72	47.13	+6.41

NOTE: These samples were subjected to continuous atmospheric oxidation for 11 days and nights.

Both before and after subjection to atmospheric oxidation, the acid (6), with small ester number, gave the same constants

within experimental error. So this acid was not affected by oxidation.

When oxidized, the acid (6), with some (7), having a medium ester number of 20.22, gave a slight increase in saponification and ester numbers.

Oxidation of acid (7), (ester no. 40.72), gave a larger increase in saponification and ester numbers than the acid (6), with some (7). However, when acid (7) is oxidized alone it is not affected as much as when mixed (Table 3) in about equal proportions with acid (6). Probably acid (6) has a catalyzing effect.

These results show that acid (7) is the only acid in Manila copal that is affected by atmospheric oxidation. When this acid is oxidized it is partly converted into lactone as shown by the increase in ester number.

In addition to our laboratory oxidation experiments we also investigated the atmospheric weathering of Manila copal adhering to the copal tree.

When the copal resin emerges from the tree the outer surface of the copal soon hardens. As the exudation continues, the fresh copal forces the hardened surface copal outward and the deposit gradually enlarges. The surface portion of a large block of copal is therefore much older than the interior portion. Since the surface is in contact with the air it is likely to be oxidized and to contain more of the insoluble gelatinous material (polymer) than the interior part.

Nagel and Körnchen [15] studied the solubility of copals in relation to their age. They concluded from their work that copals decrease in solubility with age as a result of the formation of compounds of high molecular weight.

We procured a block of copal that had a dull, brown surface. The surface was quite weathered, thus having the appearance of copal that was rather old. When cut in half, the interior part was found to be light yellow, and it appeared to be a much more recent exudation than the outer portion.

Samples were taken from the exterior and interior of this block of copal and the constants determined. The insoluble matter was separated from these samples and heated until the gel, if present, was converted to brittle resin (text fig. 3). The brittle resin was then removed by alcohol and the amount determined. The latter represented the insoluble gel originally

[15] Wiss. Veroffentlisch. Siemens-Konzern 13, No. 3 (1934) 42.

contained in the copal. Data on these samples are recorded in Table 5.

TABLE 5.—*Weathering of Manila copal.*

Constants.	Copal.		Difference.
	Interior.	Exterior.	
Saponification No.	155.47	193.15	+37.69
Acid No.	97.37	103.30	+ 5.93
Ester No.	58.10	89.85	+31.75
Acetyl No.	115.50	151.16	+35.66
Insoluble gel converted to soluble brittle copal	None	3.08	+ 3.08

Weathering of copal resin adhering to the tree (Table 5) gave, in general, about the same kind of results as oxidation in the laboratory (Table 1). In both cases oxidation of the copal gave an increase in all the constants determined.

The insoluble gel produced during ageing of the copal on the tree was 3.08 per cent (Table 5) while in the laboratory oxidation experiment the copal acquired only 0.72 per cent increase in insoluble gel (Table 1). Copal on the tree is not only subjected to atmospheric oxidation but also to the effects of weathering, especially the action of sunlight, which darkens the copal and also probably tends to increase the gel formation. Brooks[16] found that sunlight accelerates the oxidation of copal by air.

SUMMARY

Manila copal is one of the important minor forest products of the Philippines. In general, it is composed mostly of resin acids (5) (text fig. 1), together with some terpenes, resenes, and insoluble matter.

Copal that contains much material insoluble in alcohol is considered low grade and is not purchased for export by local dealers. The insoluble matter usually consists of a grayish gel that is contaminated with foreign material (dirt and the like). When the insoluble matter is heated properly the gel in it is converted into a brittle resin soluble in alcohol.

Analysis (text fig. 3) of the soluble copal obtained from the impure brittle resin shows that it is composed almost entirely of resin acids (10) that are contaminated with very small amounts of terpenes and resenes.

[16] Philip. Journ. Sci. § A 5 (1910) 226.

Since oxidation is apparently an important reaction in the ageing of Manila copal, experiments were carried out to determine the exact effects of oxidizing this resin.

A rapid current of air was passed for thirty days and nights through powdered copal. The result was a marked increase in the ester number indicating the formation of lactones. Polymerization of the lactone gave only a small amount of insoluble gel. These results showed that Manila copal was oxidized but not to any considerable extent. Probably the lactone that is formed in the copal tends to act as an antioxidant.

The resin acids (5) (text fig. 1) were isolated and exposed to atmospheric oxidation in the same manner as the copal. They were oxidized even less than the copal, due probably, to lactone formation in the acids and also to the absence of terpenes and resenes. One or both of these tend to promote oxidation of the copal.

Resin acids (5) consist of two acids, (6) and (7), which have very different constants, especially saponification numbers (text fig. 2). When these acids were separated and each one subjected to atmospheric oxidation, acid (6) was not affected. Acid (7) was partly converted to lactone as shown by the increase in ester number.

Weathering of copal resin adhering to the tree (Table 5) gave, in general, about the same kind of results as oxidation in the laboratory (Table 1). In both cases oxidation of the copal gave an increase in all the constants determined. The insoluble gel produced in the copal during the period of weathering on the tree was 3.08 per cent.

As the copal ages, the resin acid (7) in the copal apparently oxidizes to a hydroxy acid. This gradually decomposes into a lactone that slowly polymerizes to an insoluble gel. The gel probably serves as a protective coating for the interior copal. It naturally absorbs copal constituents and foreign material, thus constituting the usual insoluble matter (2) that is separated in the analysis of copal (text fig. 1). When the insoluble matter is isolated and heated properly, the gel in it depolymerizes into a brittle resin.

ILLUSTRATIONS

TEXT FIGURES

STUDIES ON PHALAENOPSIS, I

THE IDENTITY OF PHALAENOPSIS AMABILIS (LINN.) BLUME AND OF PHALAENOPSIS APHRODITE REICHB. F.

By EDUARDO QUISUMBING

Chief, Natural History Museum Division
Department of Agriculture and Commerce, Manila

TWO PLATES

Those species of genus *Phalaenopsis* which occur, and are rather common in the Philippines, have intrigued me for many years. A prolonged study of these species, as they occur here, has lead to some fairly definite conclusions. The present restudy and revision of these botanically and commercially important species is the outgrowth of the observations made, and an attempt to make clear the systematic and nomenclatorial confusion with which some of them are surrounded.

Phalaenopsis amabilis seems to have had a hectic career. It is a well-known species, having had a scientific record as early as two centuries ago. It was figured and described by Rumpf in 1750, under the name *Angraecum album majus*.[1] It was discovered in Amboyna growing on trees. Osbeck [2] found it in the western extremity of Java. Specimens were sent by him to Linnæus, who described the plant under the name of *Epidendrum amabile*.[3] Roxburgh [4] later transferred the plant to *Cymbidium*, as *C. amabile*, and stated that it was a native of the Moluccas.

In 1825 Blume [5] based a new genus on the species and made the combination *Phalaenopsis amabilis*. The name *Phalaenopsis* is perhaps due to fancied resemblance of the flower to some tropical moths while on the wing.

More confusion was added when Cuming in his trip to the Philippines in 1838 discovered another moth orchid. Lindley [6]

[1] Herb. Amb. 6 (1750) 99, *t. 43*.
[2] Cited in Orch. Rev. 14 (1906) 234.
[3] Linnæus, Sp. Pl. (1753) 953.
[4] Fl. Ind. 3 (1832) 457.
[5] Bijdr. (1825) 294, *t. 44*.
[6] Lindley, Gen. & Sp. Orch. Pl. (1833) 213.

in 1833 included *P. amabilis* in his genera and species of orchidaceous plants. But in 1938 [7] he unfortunately confused the allied Philippine species with *P. amabilis*.

In 1848 *P. amabilis* appeared in cultivation. Lindley, instead of correcting his previous mistake, described it as a new species (*Phalaenopsis grandiflora*).[8]

In 1862 Reichenbach filius noted Lindley's error, and proposed the new name *Phalaenopsis aphrodite* [9] for the Philippine species collected by Cuming. Nomenclatural confusion continued for some time, and proved extremely difficult to rectify. The beautiful illustration in Curtis's Bot. Mag. 73 (1847) *t. 4297*, of the plant which flowered at Kew Gardens in the winter of 1846–1847, is doubtless a Cuming plant, not *P. amabilis* but *P. aphrodite*, as correctly interpreted by Reichenbach filius. Ames [10] in 1905 reported and described a moth orchid collected from Lamao River, Bataan Province, Philippines, and for it used the name *P. amabilis* Blume. The English description doubtless agrees well with a typical *P. aphrodite*. In 1908 Ames [11] reduced *P. aphrodite* to a variety of *P. amabilis*, and stated that "*P. aphrodite* and *P. amabilis* have always been more or less confused, the differences between them being very slight and often obscure." In Ames's herbarium he claims to have an almost complete series which shows the gradual passage of one set of characters regarded as specific into the other. He further states that the retuse character of the apex of the arms of the callus is about the only character which may be relied upon to separate the Javan from the Philippine plants. In Merrill's Enumeration of Philippine Flowering Plants [12] Ames retained *P. aphrodite* as a variety of *P. amabilis*.

There is no doubt in my mind after many years contact with thousands of living specimens of various species of *Phalaenopsis*, that *P. grandiflora* Lindl. is not distinct from the typical Javan *P. amabilis* Blume; the differences in the size of the flowers, the shape of the leaves, and the yellow cirrhi are inconsequential and of minor importance. Even the features of the callus, which is an important character separating *P. amabilis* and *P. aphrodite*,

[7] Bot. Reg. (1838) *t. 34*.
[8] Gard. Chron. (1848) 39, *fig. 1*.
[9] Hamb. Gartenz. 18 (1862) 35.
[10] Orch. 1 (1905) 101.
[11] Orch. 2 (1908) 226.
[12] Merrill, Enum. Philip. Fl. Plts. 2 (1925) 411.

are the same in *P. grandiflora* and *P. amabilis*. They are both thick, and the arms are not retuse.

Much of the confusion, even to this date, lies in the species *P. amabilis* and *P. aphrodite*. I have examined living specimens of *P. aphrodite*, collected from the Batanes Islands, from nearly all provinces of Luzon, Mindoro, and islands in the Visayas, and have compared them with those of *P. amabilis* (cultivated in Manila and seen in Java in 1938), and am convinced that the two species are distinct. The differences between the two species are so conspicuous that even gardeners and orchid peddlers in Manila can recognize them.

In the matter of distribution, *P. aphrodite* is found in South Cape and Formosa, Batanes, Luzon, Mindoro, islands of the Visayas, but not Palawan, and in Mindanao. *P. amabilis* has a peculiar distribution, being restricted in the Philippines to Palawan Island, and other small islands adjacent to it; Sulu, and the Tawitawi group; and reaches as far as Borneo, Celebes, Java, Boeroe, Amboina, and Sunda Island.

The outstanding feature of *P. amabilis* lies in the narrow middle lobe of the labellum; in *P. aphrodite* the middle lobe is very broad at the base. I agree with Professor Ames that the retuse character of the apex of the arms of the callus in *P. aphrodite* is a reliable character, which may separate the two species in question. In *P. amabilis*, this structure is not retuse. In *P. amabilis* the auricles of the middle lobe of the labellum are much reduced, measuring 1.5 mm to 3 mm. In *P. aphrodite* the auricles are rather prolonged, often measuring up to 7 mm in length but not less than 5 mm.

Phalaenopsis Sanderiana, which is suspected to be a natural hybrid between *P. Schilleriana* and *P. aphrodite* is only found in Davao, Lanao, and Zamboanga Provinces, Mindanao, and is treated here as a variety of *P. aphrodite*. The shape of the flowers is that of *P. aphrodite*, from which, however, it differs in color; in typical *P. aphrodite* the petals and sepals are flushed with delicate mauve or pale pink-purple; while in *P. aphrodite* var. *Sanderiana* they become deep rose-purple. The leaves differ in being silvery gray on the surfaces. The shape of the middle lobe of the labellum is similar to that of *P. aphrodite* with a broad base, differing slightly in details of the arms of the callus. It seems an intermediate between *P. amabilis* and *P. aphrodite*. In *P. amabilis* the side division (*a*) of the arms of the callus is much reduced and not prominent; in *P. aphrodite*

this division is fairly promiment; however in *P. aphrodite* var. *Sanderiana* this division is very prominent and well developed. The retuse condition of the apex of the arm of the callus which is very prominent in *P. aphrodite* is very inconspicuous and undeveloped in var. *Sanderiana*, so as to appear almost truncate.

Genus PHALAENOPSIS Blume

Perianthii sepala quinque patentia, inaequalis; sepala interiora latiora, superne dilatato-rotundata. *Labellum* ecalcaratum, cum ungue gynostemii confluens, tuberculo emarginato ad basim auctum; limbus trilobus; lobis lateralibus rotundatis, arcuato-inflexis; lobo medio angustato, basi hastato, apice appendicibus 2 subulatis terminato. *Gynostemium* liberum. *Anthera* gynostemio interne versus apicem insidens, rostello prominenti incumbens, bilocularis. *Massae pollinis* duae, ovales, dorso depressae, cereaceae, pedicello communi ad basin peltato elastice insidentes.

Herba parasitica. Caules radicantes, simplices. Folia rigida, lato-lanceolata, apice oblique-retusa. Flores paniculati.—BLUME, Bijdr. (1825) 294.

PHALAENOPSIS AMABILIS (Linn.) Blume. Plate 1, fig. 1; Plate 2, figs. 1 and 4 to 6.

Phalaenopsis amabilis (Linn.) BLUME, Bijdr. (1825) 294, *fig. 44;* Rumphia 4 (1848) 52, *tt. 194, fig. 1 199A* (excl. citat. Lindl.); LINDL., Gen. and Sp. Orch. Pl. (1833) 213; BENNET, Pl. Jav. Rar. (1838) 28, *t. 8;* REICHB. f., Bot. Zeit. 10 (1852) 672; in Walp. Ann. 3 (1852) 561 (excl. pars Philip.); Xen. Orch. 2 (1862) 5; MIQ., Fl. Ind. Bat. 3 (1859) 690 (excl. citat. Bot. Mag. et pars Philip.), Sumatra (1862) 274; DUCHARTRE, Journ. Soc. Imp. et Centr. Hort. Par. 8 (1862) 730; LEM., Ill. Hort. 10 (1863) Misc. 13; LINDEN and RODIGAS, Lindenia 2 (1886) 65, quoad syn. in part; ROLFE, Gard. Chron. 26 (1886) 212, *fig. 43A;* l'Orchidoph. 13 (1893) 100; *ex* Gibbs in Journ. Linn. Soc. 42 (1914) 157; KERCHOVE, Rev. Hort. Belg. 16 (1890) 25, *t. 3;* VEITCH, Man. Orch. Pl. pt. 7 (1891) 22, *t.;* STEIN, Orchideenb. (1892) 504, fig. 153; WILL., Orch. Grow. Man. ed. 7 (1894) 660, *text cut* (excl. bibliog. in parte et quoad Philip.); RIDL., Journ. Linn. Soc. 31 (1896) 292; J. J. SM., Fl. Buitenz. 6 (Orch. Jav.) (1905) 549; Fig. - Atlas (1912) *fig. 416* (excl. bibliog. in parte et quoad Philip.); Orch. Amb. (1905) 92; Nova Guinea 8 (1909) Bot. 119 (excl. Philip.); 8^B (1912) Bot. 604; 9 (1913) Bot. 100; 12^4 (1916) Bot. 455; Philip. Journ. Sci. 12 (1917) Bot. 258, ex Merr. Interp. Rumph. Herb. Amb. (1917) 177; AMES, Orch. 1 (1905) 101 (excl. desc.); 2 (1908) 224; *ex* Merr. in Journ. Roy. Asiat. Soc. Straits Branch. Special No. (1921) 196; *ex* Merr. Enum. Philip. Fl. Pl. 1 (1925) 410; SCHLTR., Orchideen ed. 2 (1927) 535, *fig. 183.*

Edipendrum amabile LINN., Sp. Pl. ed. 1 (1753) 953; ed. 2 (1763) 1351; SW., Nov. Act. Ups. 6 (1799) 67; in Schrad. Journ. Bot. 2 (1799) 210; WILLD., Sp. Pl. 4 (1805) 115; PERS., Syn. Pl. 2 (1807) 518; SPRENG., Syst. Veg. 3 (1826) 737.

Cymbidium amabile ROXB., Hort. Beng. (1814) 63, *nomen;* Fl. Ind. ed. 2 3 (1832) 457.

Phalaenopsis grandiflora LINDL., Gard. Chron. (1848) 39, *fig. 1*, REICHB. f. in Walp., Ann. 3 (1852) 561; MOORE, Ill. Orch. Pl. (1857) Phalaenop. 7; MIQ., Fl. Ind. Bat. 3 (1859) 690; HOOK., Bot. Mag. 86 (1860) *t. 5184;* GROENLAND, Rev. Hort. 32 (1860) 238, *figs. 53, 54;* GEDNEY, Floral World (1876) 323; PUYDT, Orch. (1880) 307, *t. 34;* BURB., The Garden 22 (1882) 118; HEMSL., Bot. Chal. Exped. 1 (1885) 199; WARNER and WILL., Orch. Alb. 6 (1887) *t. 277;* ROLFE, Gard. Chron. III 5 (1889) 88; in l'Orchidoph. 13 (1893) 100; GOWER, The Garden 35 (1889) 363; WILL., Orch. Grow. Man. ed. 7 (1894) 664.

Phalaenopsis aphrodite LEM., Ill. Hort. 10 (1863) Misc. 14, quoad citat. Rumph., non Reichb. f.

Phalaenopsis amabilis BLUME var. *grandiflora* BATEM, Second Cent. Orch. Pl. (1867) *t. 114.*

Phalaenopsis amabilis Blume var. *rimestadtiana* LINDEN, Lindenia 16 1902) 35, *t. 736;* edit. in Gard. Chron. III 32 (1902) 306, *t.;* PAUWELS, Rev. Hort. Belg. 29 (1903) 88, *figs. 22–24;* ROLFE, Orch. Rev. 14 (1906) 233, *fig. 27*, 23 (1915) 254.

Phalaenopsis Rimestadtiana "ARGUS," Orch. Rev. 13 (1905) 260, in textu, *nomen;* ROLFE, Orch. Rev. 25 (1917) 151, in textu, *nomen.*

Foliis radicalibus lato-lanceolatis, *petalis* lateralibus orbiculatis. *Habitat* in India. Osbeck. *Radices* crassae, funiformes, supra arborea scandentes. *Folia Crini* s. *Scillae officinalis* lata. lanceolata, carnosa, semipedalia. *Culmus* bipedalis, nudus, cinctus aliquot squamis acutis brevissimis. *Flores* nivei *Orchidis Susannae* aemuli, s. magnitudine *Narcissi:* constantes petalis 5, quorum 2 lateralia orbiculata, reliqua ovata. *Cucullus* alter triphyllus: lateralibus oblongis, intermedio hastato, bifido setis duabus subulatis.—*Epidendrum amabile* Linn. Sp. Pl. ed. 1 (1753) 953.

Leaves large, fleshy, greenish, elliptic-oblong, lanceolate or oblanceolate, apex obliquely retuse or broadly obtuse, 15 to 30 cm long, 5 to 6 cm wide. Inflorescence simple or branched, few or many-flowered, long, drooping or suberect, 20 to 50 cm long. Flowers white, odorless, large, 7.5 to 9.5 cm across. Pedicellate ovary greenish at the base, otherwise white, 4 to 5 cm long. Lateral sepals pure white, with faint yellowish green at the center on the back, obliquely lanceolate-oblong or elliptic-ovate, apex subacute or subobtuse, base contracted, 3.8 to 4.5 cm long, 1.6 to 2.1 cm wide. Dorsal sepal pure white, elliptic-oblong, apex subobtuse, 4 to 4.4 cm long, 2.3 to 2.5 cm wide. Petals pure white, broad, sub-rhomboidal, apex rounded, contracted at base, 3.8 to 4.5 cm long, 3.5 to 4.5 cm wide at the widest portion. Labellum three-lobed; lateral lobes incurved, subquadrate, apex rounded, white, lined and dotted at base with pomegranate purple, stained with empire yellow on the front lower edge, base contracted, 1.9 to 2.1 cm long, 1.1 to 1.4 cm wide at the widest portion; middle lobe narrowly linear, hastate, 1.8 to 2 cm long, white except the two auricles, cirrhi, and a line at center base

which is empire yellow, 6 to 7 mm wide at base, 2 to 3 mm wide at apex; apex bearing at the extremity two long, very slender, incurved and twisted cirrhi, 1.5 to 3 cm long, auricles subulate, short, 1.5 to 3 mm long. Claw at base of column white, dotted and pencilled with pomegranate purple. Callus 2-lobed, apricot-yellow, dotted with pomegranate-purple, arms 3 to 4 mm thick, apex not retuse, apiculate. Column white, except pale-pink anther cap, subclavate, 10 to 11 mm long. Anther cap subquadrate. Pollinia two, subquadrate, 1.8 to 2 mm long.

PHILIPPINES, PALAWAN, without locality, *Bur. Sci. 10866 Celestino*, July 6, 1910; Brooks Point, *Elmer 12614*, March, 1911, *Bur. Sci. 81133, 81137a Taylor*, September, 1923; Taytay, *Merrill 9174*, April 30, 1913; without locality, *Bur. Sci. 21586 Escritor*, August 7, 1913. LUMBUGAN ISLAND, SULU, *Merrill 7188*, September 20, 1910. TAWITAWI, *Bur. Sci. 44256 Ramos and Edaño*, July 19, 1924. LUZON, Rizal Province, Pasay, cultivated in Quisumbing's garden, *Phil. Nat. Herb. 6942 Quisumbing*, October 20, 1940; originally collected by Mr. Edwards from around Brooks Point, Palawan. In addition to above the author has in cultivation many plants from Palawan, and also flowers of the species, preserved in liquid, from various gardens in Manila and from Java. The species is found outside of the Philippines in Java, Borneo, Celebes, Boeroe, Amboyna, and the Sunda Islands.

PHALAENOPSIS APHRODITE Reichb. f. Plate 1, Fig. 2; Plate 2, Figs. 2 and 7 to 9.

Phalaenopsis aphrodite REICHB. F., Hamb. Gartenz. 18 (1862) 35; Xen. Orch. 2 (1862) 6; DUCHARTRE, Journ. Soc. Imp. et Centr. Hort. Par. 8 (1862) 730; LEM., Ill. Hort. 10 (1863) Misc. 14 (excl. citat. Rumph.); ROLFE, Gard. Chron. 26 (1886) 212, *fig. 43 B*; Orch. Rev. 2 (1894) 209, *fig. 30;* 8 (1900) 135–136, *fig. 20;* 13 (1905) 232, *fig. 52; ex* Forbes and Hemsl. in Journ. Linn. Soc. 36 (1903) 34; PFITZ. in Engl. and Prantl, Nat. Pflanzenfam. 2 pt. 6 (1889) 211, *fig. 230;* VEITCH, Man. Orch. Pl. pt. 7 (1891) 24, *t.;* STEIN, Orchideenb. (1892) 505, *fig. 155;* COGN. in Dict. Icon. Orch. (1898) Phalaenop. *t. 1;* edit. in Sem. Hort. 4 (1900) 392, *fig. 132;* MATSUM., Ind. Pl. Jap. 2 (1905) 257; AMES, Orch. 1 (1905) 102 (desc.); Philip. Journ. Sci. § 2 (1907) 336; *ex* Merr. Enum. Philip. Fl. Pl. 1 (1925) 412; SCHLTR., Fedde. Repert. 4 (1919) 277; Orchideen ed. 2 (1927) 537.

Phalaenopsis amabilis HOOK., Bot. Mag. 73 (1847) *t. 4297* non Blume.

Leaves elliptic-oblong, ovate-oblong or obovate-oblong, apex obtuse to rounded, 10 to 25 cm long, 5 to 9 cm wide, greenish on both surfaces or greenish above and purplish-green beneath. Peduncles variable in length, greenish and usually tinged with

madder-purple, erect, arching or drooping, few- to many-flowered, 30 to 90 cm long. Flowers odorless, 5.5 to 8.5 cm across. Pedicellate ovary white, greenish-yellow at base, slender, 2.5 to 3.2 cm long. Lateral sepals ovate or ovate-lanceolate, apex subacute, falcate, 2.6 to 3.8 cm long, 1.5 to 2.1 cm wide at widest portion, white, flushed with pale yellowish green and dotted at base with purple. Dorsal sepal white, oblong-elliptic, obtuse, 2.4 to 3.8 cm long, 1.4 to 2.0 cm wide. Petals white, broad, subrhomboidal, contracted at base, 2.7 to 3.8 cm long, 2.7 to 3.9 cm wide at the widest portion, broadly obtuse or rounded. Labellum 3-lobed; lateral lobes contracted at base, incurved, subquadrate, 1.5 to 2.1 cm long, 1.2 to 1.6 cm wide; apex truncate or somewhat rounded, white, within base yellow, spotted and pencilled with purple; middle lobe hastate with a broad base, 1.6 to 2.3 cm long, base above auricles 7 to 12 mm wide, apex 2 to 4 mm wide, white except with yellow or yellow and purple mixed at base above auricles, auricles prominent with a broad base, triangular or subulate, 6 to 10 mm long, 3 to 6.5 mm wide at base, apex terminating in two filiform, tendrillike divisions (cirrhi), these 12 to 20 mm long; crest or callus thin, 0.8 to 1 mm thick, 2-lobed, yellow spotted with red or purple, apex of arms or lobe prominently retuse. Column white, short, subterete, 7 to 8 mm long. Anther cap beaked, subquadrate. Pollinia two, subglobose.

In habit *P. aphrodite* resembles *P. amabilis*. The leaves are practically the same in shape and color except that in *P. aphrodite* there is a flush of purple beneath. The most important feature, however, and the one which separates *P. aphrodite* from *P. amabilis*, is the labellum and the callus. In *P. aphrodite* the middle lobe of the labellum is hastate with a broad base; the callus is thin, with very prominent terminal retuse lobe or arm. *P. aphrodite* is very variable in the Philippines,—variations in the shape and color of the leaves, size and color of the flower parts, the shape of the labellum particularly the middle lobe, and the length of the cirrhi are not uncommon. Three varieties have been published, but many more varieties and forms could be added. A separate account on the study of these various varieties and forms will be published separately.

The distribution of *Phalaenopsis aphrodite* is rather interesting. The only record we have outside of the Philippines is from South Cape and Formosa. In the Philippines the species reaches only as far as the Visayas, not to Palawan or Mindanao. We

have records of the species from Batan and Camiguin, two islands north of Luzon, and it is found southward, in practically all provinces of Luzon. The species is common in both primary and secondary forests at low and medium altitudes. It flowers practically throughout the year.

PHILIPPINES, BATAN ISLAND, Mount Iraya, *Bur. Sci. 80798 Ramos*, April 30, 1930. CAMIGUIN ISLAND, Mount Malabsing, *Bur. Sci. 79589 Edaño*, March 13, 1930. LUZON, Ilocos Norte Province, Bangui, *Bur. Sci. 7647 Ramos*, March, 1909: Ifugao Subprovince, Payauan, *Bur. Sci. 20026 McGregor*, January 24, 1913: Nueva Vizcaya Province, vicinity of Dupax, *Bur. Sci. 11133 McGregor*, April, 1912: Nueva Ecija Province, without definite locality, *Bur. Sci. 12318 Foxworthy*, January 31, 1911: Zambales Province, Tangil, *For. Bur. 6914 Curran*, May 6, 1907: Bataan Province, Lamao, *For. Bur. 680 Borden*, May 7, 1904: Pampanga Province, Mount Arayat, *For. Bur. 19311 Curran*, March, 1910; Rizal Province, Montalban, *Loher, s. n.*, May, 1909; Mount Purro, *Bur. Sci. 12526 Ramos*, November 26, 1910; Mount Susong-dalaga, *Bur. Sci. 19242 Reillo*, December 6, 1912; without locality, *Bur. Sci. 3058 Ramos*, November 21, 1907: Laguna Province, Los Baños, *Quisumbing 1043*, December 29, 1917; Mount Maquiling, *Bur. Sci. 17134 Robinson*, December 9, 1912; Calauan, *Bur. Sci. 12390 McGregor*, December 8, 1910: Tayabas Province, Basiad, *Bur. Sci. 25573 Yates*, December 19, 1916; Casiguran, *Bur. Sci. 45533 Ramos and Edaño*, June 13, 1925; Laguimanoc, *Merrill 4017*, March 12, 1905; Mount Cadig (Guinayangan), *Bur. Sci. 20822, 20856, 20682, Escritor*, March 7, 1913; Camarines Sur Province, Ragay, *For. Bur. 11342 Curran*, May 10, 1908: Sorsogon Province, Mount Bulusan (Mount Irosin), *Elmer 15478*, September, 1916. MINDORO, Alag River, *Merrill 5845*, December 3, 1906; Lake Naujan, *For. Bur. 6789 Merritt*, April 5, 1907. BILIRAN, *Bur. Sci. 19915 McGregor*, May 30, 1914, *Bur. Sci. 18877 McGregor*, June 20, 1914. LEYTE, Cabalian, *Lopez 3407*, May 18, 1921. SAMAR, Paranas, *Bur. Sci. 17571 Ramos*, April 12, 1914. NEGROS, Occidental Negros Province, Sagay, *For. Bur. 5544 Everett*, October 18, 1906.

PHALAENOPSIS APHRODITE var. SANDERIANA (Reichb. f). Quis. comb. nov. Plate 1, fig. 3; Plate 2, figs. 3 and 10 to 12.

Phalaenopsis sanderiana REICHB. F., Flora 65 (1882) 466; Gard. Chron. 19 (1883) 607, 656; 20 (1883) 110; BURB., The Garden 24 (1883) 270, *t. 407;* edit. in l'Orchidoph. 3 (1883) 661; GODEFR.-LEBŒUF, l'Orchidoph. 5 (1885) 18, *t.;* LINDEN and RODIGAS, Lindenia 1 (1885) 51, *t. 23;* WILL., Orch. Grow. Man. ed. 6 (1885)

535; ed. 7 (1894) 670; ROLFE, Gard. Chron. II 26 (1886) 212; Orch. Rev. 8 (1900) 133; 15 (1907) 185, *fig. 22;* l'Orchidoph. 13 (1903) 101; WARNER and WILL., Orch. Alb. 5 (1886) *t. 209;* GOWER, The Garden 35 (1889) 363; ROEBELEN, Gard. Chron. III 7 (1890) 459, in textu; STEIN, Orchideenb. (1892) 511; KRÄNZL. in Sander Reichenbachia II 2 (1894) 41, *t. 68* (upper fig.); COGN. in Dict. Icon. Orch. (1903) Phalaenop. Hybr. *t. 2;* G. WILSON, Orch. World 6 (1916) 266.

Phalaenopsis amabilis Blume var. *aphrodite* (Reichb. f.) Ames subvar. *Sanderiana* (Reichb. f.) AMES, Orch. 2 (1908) 228; in Merr. Enum. Philip. Fl. Pl. 1 (1925) 412.

In habit similar to the species. Leaves oblong, oblong-obovate, or oblong-oblanceolate, apex obtuse or subrounded, dark green, marked on the upper surface with silvery gray, the lower surface sometimes with a flush of dull brownish-purple, 15 to 27 cm long, 6 to 9 cm wide. Inflorescence branched or unbranched, 30 to 80 cm long. Flowers faintly fragrant, 7 to 9 cm across. Lateral sepals obliquely ovate, apex acute, basal margin on broader side undulate-recurved, almost white, flushed with pale mauve particularly on narrower side, 3 to 3.6 cm long, 1.8 to 2.2 cm wide. Dorsal sepal oblong, subacute, or subobtuse, very delicate mauve or pale pink-purple, 3 to 3.6 cm long, 1.8 to 2.3 cm wide. Petals subrhomboidal or subrounded, broadly obtuse or subrounded, base cuneate, same color as dorsal sepal, 1.9 to 3.8 cm long, 1.9 to 3.8 cm wide at widest portion. Labellum 3-lobed; lateral lobes incurved, rounded or semi-ovate, apex rounded, base contracted as in the species, 1.8 to 2.1 cm long, 1.2 to 1.3 cm wide at widest portion, white, upper edge pencilled and spotted with eugenia red, lower edge cadmium yellow; middle lobe white, streaked with purple along the center, hastate with a broad base, similar in shape to species, 1.9 to 2 cm long, base above auricles 1.2 to 1.3 cm wide, apex below cirrhi 3 to 3.5 mm wide; cirrhi white, 1.2 to 1.5 cm long; auricles narrowly triangular, with a broad base, 7 to 9 mm long, cadmium yellow; callus 2-lobed, thin as in species, apex of arms truncate or obscurely retuse, white or yellowish, spotted with brown or purple brown, side division prominent. Column subterete, white with a short mauve-tinted beak, 8 to 9 mm long.

PHILIPPINES, MINDANAO, Davao Province, Davao, *Copeland, s. n.*, October, 1904; *Rev. Black, s. n.*, October 24, 1905; Todaya (Mount Apo), *Elmer 10883a*, May, 1909: Lanao Province, Camp Keithley (Lake Lanao), *Clemens, s. n.*, July, 1907: Zamboanga Province, Malangas, *Bur. Sci. 37109 Ramos and Edaño*, November 16, 1919. IGAT ISLAND, Dumanguilas Bay, Zamboanga Prov-

ince, *For. Bur. 12361 Hutchinson*, May 7, 1908. MANILA, cultivated in gardens, plants originally from Davao Province, *Bur. Sci. 78917 Quisumbing*, March 30, 1930; *Mrs. K. B. Day 19154*, February, 1930; *Bur. Sci. 82210 Quisumbing*, January 15, 1931; *Bur. Sci. 84572, 84573 Quisumbing*, January 17, 1932; *Bur. Sci. 84704, 84705 Quisumbing*, July 2, 1932. In forests at low altitudes up to 100 meters. Endemic.

In growth and habit similar to the species; differing in the presence of silvery gray on the upper surface of the leaves, the color of the sepals and petals and the details of the callus. The sepals and petals, instead of being white as in the species, are flushed with a pleasing delicate mauve or pale pink-purple. In some forms these are almost white, while in others the color is more intensified, that is, they are of deep rose-purple. The callus is thin as in the species,—unlike in *P. amabilis* where it is conspicuously thick. The apex of the arm of the callus is not retuse as in the species, but truncate or very obscurely retuse; the side division of the arm is very prominent; in some cases the side division is so prominent that with the apex the arm appears retuse. The white form, except the details of the callus and the silvery gray of the surface of the leaf, almost resembles the species. Three varieties had been previously recognized and published but these have not been recognized here to merit varietal rank as they represent color variations and differences and not morphological differences.

ILLUSTRATIONS

Plate 1

FIG. 1. *Phalaenopsis amabilis* (Linn.) Blume; reduced.
2. *Phalaenopsis aphrodite* Reichb. f. var. *Sanderiana* (Reichb. f.) Quis.; reduced.
3. *Phalaenopsis aphrodite* Reichb. f. typical; reduced.

Plate 2

FIG. 1. *Phalaenopsis amabilis* (Linn.) Blume, labellum expanded; × 1.
2. *Phalaenopsis aphrodite* Reichb. f., labellum expanded; × 1.
3. *Phalaenopsis aphrodite* Reichb. f. var. *Sanderiana* (Reichb. f.) Quis., labellum expanded; × 1.

FIGS. 4 to 6. *Phalaenopsis amabilis* (Linn.) Blume, three views of the callus showing apiculate arms and the very inconspicuous side division of the lobe or arm; × 4.
7 to 9. *Phalaenopsis aphrodite* Reichb. f., three views of the callus showing very conspicuous retuse apex of the arms and the prominent side division; × 4.
10 to 12. *Phalaenopsis aphrodite* Reichb. f. var. *Sanderiana* (Reichb. f.) Quis., three views of the callus showing the truncate or very obscure retuse apex of the arm (*a*), and very prominent side division (*b*); × 4.

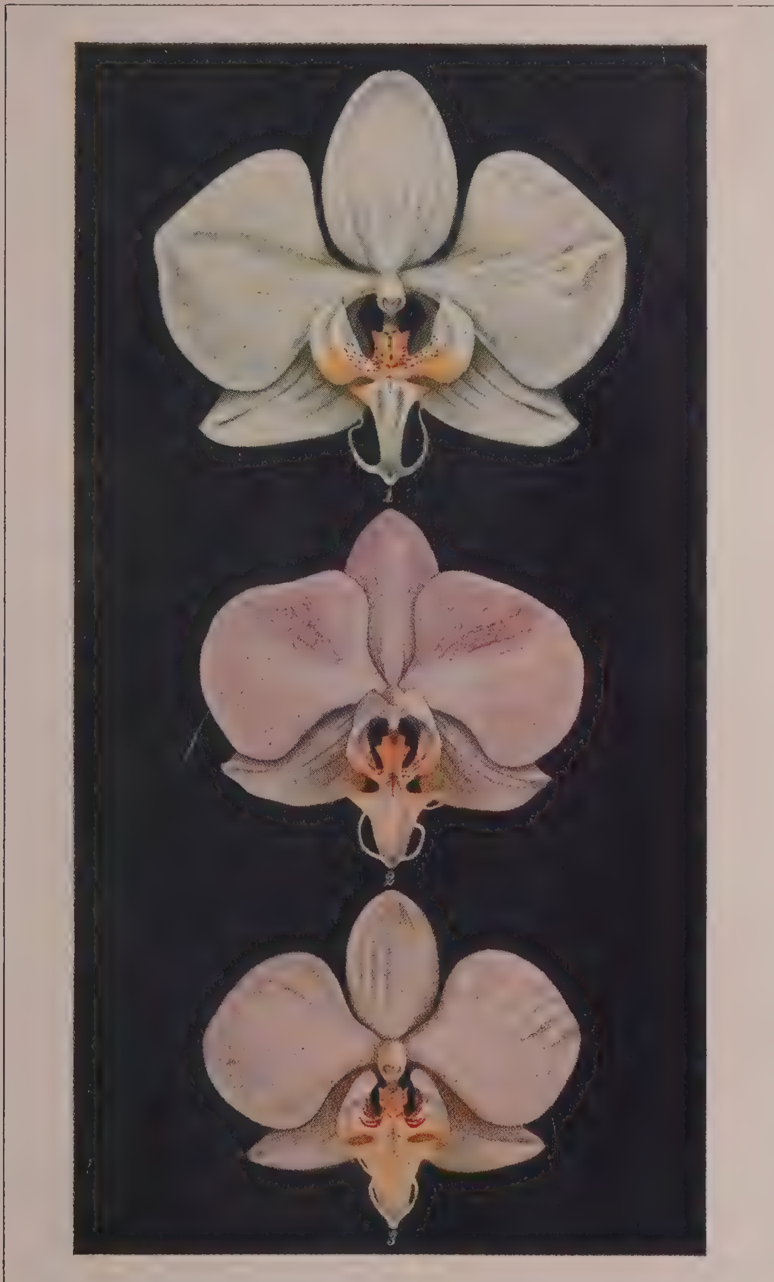


PLATE 1.

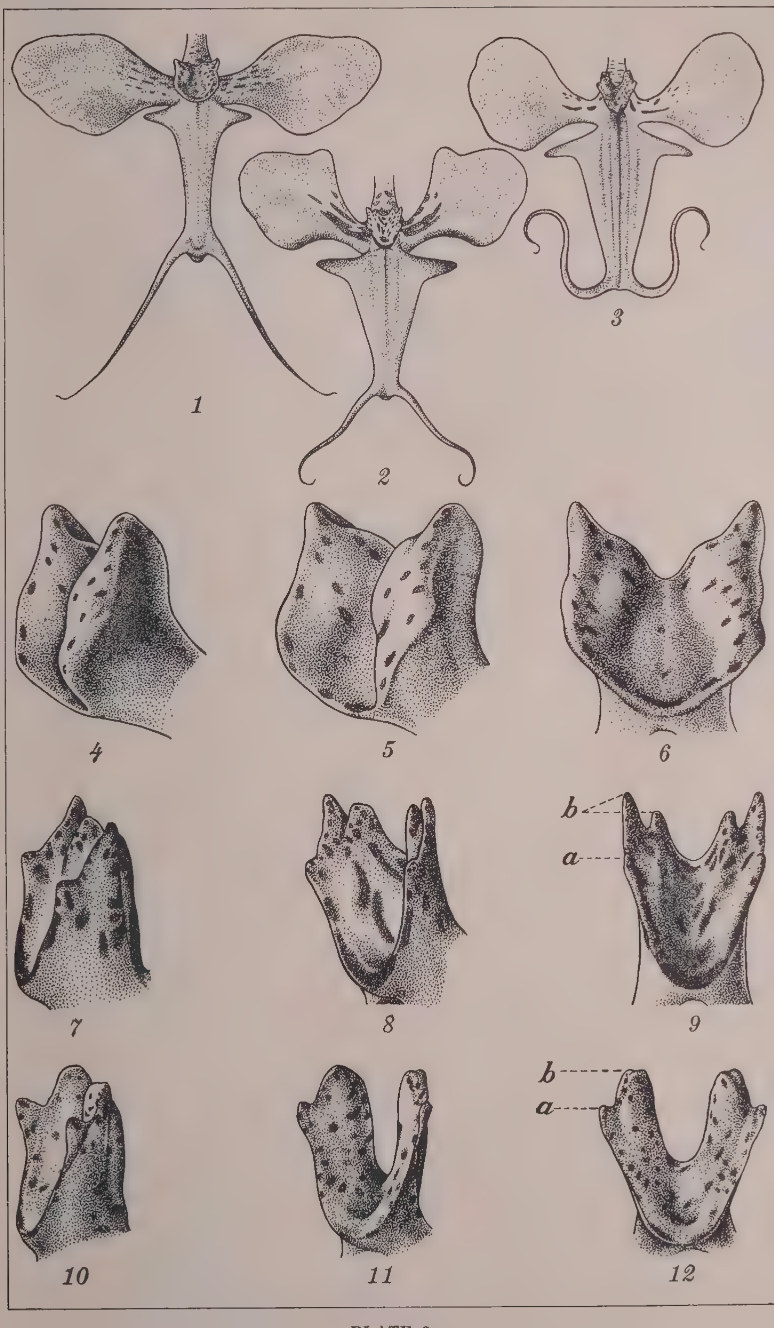


PLATE 2.

BOOKS

Books reviewed here have been selected from books received by the Philippine Journal of Science from time to time and acknowledged in this section.

REVIEWS

Researches in Cancer: Part One (1896–1921; 1922–1932). By Caleb Wyand Geting Rohrer. Baltimore, The Brentwood printing company, 1934. 144 pp., front., illus. Price, $3.50.

This book presents a novel theory dealing with the relation of premature birth to cancer. The author also makes use of his "fetal-cell suspension" in the treatment of human cancer and claims encouraging results. This part of the book ought not to be accepted without due deliberation, lest the reader may try it at the sacrifice of surgery, X-ray, and radium, which, up to this time, are the only methods regarded as effective in the treatment of cancer.

The biography of Professor Cohnheim and his relation to cancer research is both interesting and inspiring and make the book worth reading by those interested in the cancer problem.

—P. S. C.

End-results in the Treatment of Gastric Cancer; An Analytical Study and Statistical Survey of Sixty Years of Surgical Treatment. By Edward M. Livingston and George T. Pack. With a Foreword by Bowman C. Crowell. New York, London, Paul B. Hoeber, Inc., 1939. 179 pp., illus. Price, $3.

This book is interesting and profitable to the surgeon, radiologist, clinician, and general practitioner, because the presentation of the subject is practical, analytical, and graphic. It is practical in the sense that it portrays certain gastric cancers which may be cured if found early and operated, as evidenced by the analytical studies of abundant and rich material furnished by reputable institutions of the different countries of the world.

Due to the great incidence of malignancy of cancer of the stomach affecting the human race, this piece of work may be considered among the most significant, because it furnishes the cancerologist important information that will serve as a guide and an encouragement to those whose interest lies principally in

the lessening of cancer mortality by surgical intervention.—P. S. S.

Quantitative Biological Spectroscopy. By Elmer S. Miller. Minneapolis, Minnesota, Burgess Publishing Company, 1939. 213 pp., illus. Price, $3.50.

This mimeographed pamphlet of 213 pages contains a concise but complete description of modern spectroscopic apparatus used in the determination of absorption bands of organic substances. Starting with a minutious discussion of the fundamental principles of spectrum analysis and the sources of error, the actual spectroscopic analyses taken up deal with vitamins, lipids, hæmoglobin, cytochrome, and plant pigments. An extensive bibliography is found at the end of each chapter. The author's complete grasp of the physics principles involved is admirable, considering that his special line of work is botany.—N. C.

I Knew 3000 Lunatics. By Victor R. Small. New York, Farrar & Rinehart, Inc., 1935. 273 pp. Price, $2.50.

As a treatise for bringing the science of psychiatry to the layman, devoid of technicalities and intricacies, this book well fulfills its mission. In simple and easily understood language the author proceeds to tell of his experiences as a staff member in an insane asylum where approximately 3000 inmates are housed. He gives a concise and vivid picture of the behavior and the manner of living of each of the more common types of the insane and the mentally deficient. He does this in such an interesting manner that the reader will not want to lay down the book until he finishes it.

This book serves as very good preliminary reading for students intending to take a course in psychiatry. The student will get a clear idea of what the subject is about, its scope and its practical applications. From the borderline cases of the psychoneuroses to the well-confirmed schizophrenics, he will get a vivid picture of what these concepts represent. Finally the author gives a first-class classification of mental diseases, devoid of technicalities, and a chapter on forensic psychiatry wherein he enumerates some of the glaring discrepancies in opinion between the experts and the law.—D. S.

Modern Sewage Disposal; Anniversary Book of the Federation of Sewage Works Associations. Edited by Langdon Pearse. New York, The Federation, 1938. 371 pp., illus. Price, $3.50.

This book treats of the history and methods of sewage disposal and treatment as practiced in the United States, England,

South Africa, the Netherlands, and Germany. Under the editorship of Langdon Pearse and under the direction of Dr. F. W. Mohlman, it was written by chosen research workers, engineers. and other authorities who have distinguished themselves in their respective fields. It describes the latest methods of sewage treatment as well as methods of disposal of waste and sewage effluents for irrigation or as fertilizer in the form of digested sludge.

The vast amount of research conducted in sewage treatment plants now in operation and in 36 educational institutions in the United States is well and concisely covered by this volume. It is more thorough and comprehensive than an ordinary text on the subject. As stated in the foreword, "this Anniversary Volume is an effort to replace a convention of world-wide workers by a contributed set of papers along unusual topical lines."

The book is an excellent reference work for sanitary engineers, especially for those engaged in the designing and operation of sewage treatment plants.—G. de L.

Electric Welding: A Practical Text Covering the Fundamental Principles and Applications of the Various Types of Electric Arc Welding, Including the use of Power Tube Rectifiers. By Morgan H. Potter. Chicago, American Technical Society, 1938. 126 pp., illus. $1.25.

Electric Welding by Morgan H. Potter is a practical text covering the fundamental principles and applications of the various types of electric arc welding, including the use of power tube rectifiers. The importance of the welding industry in the United States has grown so rapidly that the large demand for competent welders and welding engineers can hardly be met at the rate they are trained.

The book is very practical and comprehensive, and as such it will serve best in providing the beginner and the inexperienced welder with the technical and practical information he needs to become an expert welder. The book also discusses and illustrates important improvements in the design and control of welding machines as well as improvements in the welding rod and welding technique. All the various methods of welding are dealth with, namely, Thermit, Electric resistance, Spot, Butt, Electric arc, Carbon arc, and Metallic arc.

The use of Power tube rectifiers may be considered one of the foremost achievements in the science of electric welding. With complete accurate control of the current, voltage, and time by Ignitron timers, as illustrated in this book, spot and seam welding can be accomplished very effectively.—F. D. M.

Cotton Progress in Brazil. By N. S. Pearse. Manchester, England, International Federation of Master Cotton Spinners and Manufacturer's Associations, 1937. 183 pp., illus.

This pamphlet, in ten chapters, deals with the progress made in the cotton growing industry in Brazil. How climatic and weather conditions and soil types affect the cotton industry in Brazil is well explained. The pamphlet also explains how the ginning laws, particularly the Sâo Paulo laws, aid in increasing the demand of spinners as a result of the uniformity of staples set up and produced under such laws. The low cost in production made possible by cooperation among the ginner, the shipper, and the spinner, contributes largely to the progress made in this industry.

In Chapter ten the conditions prevailing and the most suitable methods used in the different states make possible the production of an improved and high grade cotton at very low cost. Apparently, with all these favorable conditions obtaining in Brazil, its cotton industry is a real asset. The author did not incorporate in the pamphlet possible further improvements in the industry as a whole, such as the general adoption by the country of the Cotton laws of Sâo Paulo and research work on the maximum density and other characteristics of Brazilian cotton, including the most advantageous and profitable baling. —T. G.

From Forest to Woodworker. By L. H. Noble and R. B. Everill. New York, The Bruce Publishing Co., 1938. 252 pp., illus. Price, $1.75.

As an introduction to the science of forestry and to the art of woodworking, this profusely illustrated book is a valuable addition to the library of all natural science and woodworking instructors as well as students. In clear, concise language, it imparts to the reader practical information on the measuring and grading of lumber, the application of paints, varnishes, and lacquers, as well as the use and proper care of woodworking tools. A whole chapter is devoted to the importance of conservation in the utilization of existing forest wealth.—T. N. R.

Modern Agricultural Mathematics. By Maurice Nadler. New York, Orange Judd Publishing Company, 1940. 315 pp., illus. Price, $2.

This book, in two parts, gives a detailed and comprehensive discourse on the application of mathematical principles to a variety of farming activities.

Part I of the book seeks to develop, by logical steps, various rules and formulas used in measurement of length, direction,

area, and volume, and also specific relationships between the different units of measure. Mathematical principles presented are followed by a series of farm problems and sample solutions. Certain applications have been given special detailed presentation, as for example, crops and orchards, and the measurement of lumber and timber. In Part II a detailed consideration of dairying, feeding of farm animals, soil fertility, fertilizers, farm mechanics, and finance and management, provides the necessary skill in calculation.

This book is profusely illustrated by graphs, diagrams, and photographs. Valuable tables necessary in scientific farming are given in the appendix. This text will be of invaluable service to those training for or now engaged in agricultural pursuits.—D. B. P.

The Drama of Weather. By Sir. Napier Shaw. 2d. ed. Cambridge, at the University Press, 1939. 307 pp., front., illus. Price, $3.50.

This is the second edition, partly revised, of one of Sir Napier Shaw's entertaining and instructive books on the weather. It is popular in style in the sense that it is not written for meteorologists as such, but it is certainly unlike the usual run of popular books on science. It is rather written for well-educated nonmeteorologists skillfully endeavoring to make them share the thrill there is in watching the play and interplay of the various elements that go to make up the elusive thing we call weather.

Sir Napier's style is felicitous, and even veteran meteorologists can find much food for thought in the side remarks and reflections which are plentifully strewn over the pages, the mature fruit of many years of musing by the dean of English weather men. The illustrations are, for the most part, excellent, and the author's dexterous use of graphs very commendable.—C. F. D.

RECEIVED

Adam, T. R. The museum and popular culture. New York, American association for adult education, 1939. 177 pp. Price, $1.

Butler, J. A. V. Electrocapillarity; the chemistry and physics of electrodes and other charged surfaces. New York, Chemical publishing co., inc., 1940. 208 pp., illus. Price, $5.

Camm, F. J. ed. A dictionary of metals and their alloys, their composition and characteristics. With special sections on plating, polishing, hardening and tempering, metal spraying, rustproofing, chemical colouring and useful tables. New York, Chemical publishing co., inc., 1940. 245 pp. Price, $3.

The detection and identification of war gases. Notes for the use of gas identification officers. 1st Am. ed. New York, Chemical publishing co., inc., 1940. 53 pp. Price, $1.50.

DIEHL, HARVEY. The applications of the dioximes to analytical chemistry. Columbus, Ohio, The G. Frederick Smith chemical co., 1940. 62 pp., illus.

Drilling and production practice, 1938. Sponsored by the Central committee on drilling and production practice, Division of production, American Petroleum institute. New York, American petroleum institute, 1939. 458 pp., illus. Price, $3.

GAER, JOSEPH. Fair and warmer. The problem of weather forecasting and the work of the United States weather bureau. New York, Harcourt, Brace and company, 1939. 137 pp., illus. Price, $1.

HEISS, ELWOOD, D., and others. Modern methods and materials for teaching science. New York, The Macmillan company, 1940. 351 pp., illus. Price, $2.50.

JANSSEN, RAYMOND E. Leaves and stems from fossil forests. A handbook of the paleobotanical collections. (Popular science series vol. 1). Springfield, Illinois State museum, 1939. 190 pp., illus. Price, paper, $1.25.

KNANDEL, H. CLYDE. Profitable poultry keeping. New York, Orange Judd publishing co., inc., 1940. 462 pp., illus. Price, $3.

MANLY, HAROLD P., and L. O. GORDER. Drake's cyclopedia of radio and electronics. A practical reference book. 9th ed. Chicago, Frederick J. Drake & co., 1939. unpaged. illus. Price, $5.

MAY, PERCY, and G. MALCOLM DYSON. May's chemistry of synthetic drugs. 4th ed., rev. rewr. London—New York—Toronto, Longmans, Green and co., 1939. 370 pp., illus. Price, $6.

The meteorological glossary. In continuation of the weather map. Published by the authority of the meteorological committee. 3d. ed. New York, Chemical publishing co., 1940. 251 pp., illus. Price, $3.

National geographic society, Washington, D. C. The book of birds. The first work presenting in full color all the major species of the United States and Canada. Washington, D. C., The society, 1939. 2 v., illus. Price, $5.

PATTEE, ALIDA FRANCES. Practical dietetics with reference to diet in health and disease. 22d. ed. Mount Vernon, New York, The author, 1940. 880 pp., illus. Price, $3.

PETERSON, ANNA J., and NENA WILSON BADENOCH. Delectable dinners. New York, E. P. Dutton & co., inc., 1939. 460 pp. Price, $2.50.

PHILIPS, A. H. Gardening without soil. New York, Chemical publishing co., inc., 1940. 137 pp., front., illus. Price, $2.

Another issue. London, Arthur Pearson. n. d.

Popular science talks. Presented by members of the faculty of the Philadelphia college of pharmacy and science and published under the auspices of the American journal of pharmacy. Philadelphia, Philadelphia college of pharmacy and science. 241 pp., illus. Price, $1.

REED, C. I., and others. Vitamin D. Chemistry, physiology, pharmacology, pathology, experimental and clinical investigations. Chicago, The University of Chicago press, 1939. 389 pp., illus. Price, $4.50.

REMINGTON, J. STEWART, and F. L. JAMESON. Metallurgical analysis and assaying. London, The Technical press ltd., 1939. 101 pp. Price, 5s/-.

SANSUM, W. D., and others. A manual for diabetic patients. New York, The Macmillan company, 1939. 227 pp., front., illus. Price, $3.25.

VERRILL, A. Hyatt. Minerals, metals and gems. Boston, L. C. Page & company, 1939. 293 pp., front., illus. Price, $3.

WADDINGTON, C. H. An introduction to modern genetics. New York, The Macmillan company, 1939. 441 pp., illus. Price, $4.

WEISKOTTEN, HERMAN G., and others. Medical education in the United States 1934–1939. Prepared for the council on medical education and hospitals of the American medical association. Chicago, American medical association, 1940. 259 pp., illus. Price, $1.

THE PHILIPPINE BUREAU OF SCIENCE

THE PHILIPPINE JOURNAL OF SCIENCE

Manuscripts intended for publication in the Philippine Journal of Science should be sent to the Editor, Philippine Journal of Science, Bureau of Science, post-office box 774, Manila, Philippines.

Manuscripts on biology must be accompanied by abstracts for publication in the Biological Abstracts.

Fifty separates of each paper published in the Journal are furnished to the author without charge. Additional copies may be had at the author's expense if ordered when the manuscript is submitted for publication.

The Journal is issued twelve times a year. The subscription price is 5 dollars United States currency per year. Single numbers, 50 cents each.

Subscriptions may be sent to the Division of Publications, Department of Agriculture and Commerce, post-office box 613, Manila, Philippines, or to any of the agents listed below.

Publications sent in exchange for the Philippine Journal of Science should be addressed: Scientific Library, Bureau of Science, post-office box 774, Manila, Philippines.

AGENTS

The Macmillan Company, 60 Fifth Avenue, New York, N. Y.
Martinus Nijhoff, Lange Voorhout 9, The Hague, Holland.
G. E. Stechert & Co., 31–33 East 10th Street, New York, N. Y.
The Maruzen Co., Ltd., 6 Nihonbasi, Tori-Nichome, Tokyo, Japan.

CONTENTS

The articles in the Philippine Journal of Science are indexed in the International Index to Periodicals, New York, N. Y.